

CARBON2021 **FOOTPRINT** REPORT



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Message from the President

In order to mitigate the spread of the coronavirus (COVID-19), the University has put in place numerous safety precautions and requirements based on the recommendations of World Health Organization (WHO), the Egyptian Ministry of Health and Population (MOH) and the Centers for Disease Control and Prevention (CDC). Our AUC community has shown resilience and dedication in facing the COVID-19 pandemic, adapting to necessary changes in campus operations and functions. The persistent operational and economic effects of COVID-19 will continue to challenge our former assumptions about how we work, study, teach, and conduct research.

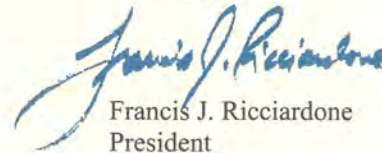
The COVID-19 pandemic has revealed how our normal actions and behaviors have serious environmental consequences. Climate change presents imminent threats to global health, security, and order. Given its harsh climate, growing population, and limited natural resources, the Middle East and North Africa region is among the most vulnerable to the threats of climate change. The pandemic poses serious setbacks to gains made to address global poverty, hunger, and well-being. Now more than ever, the global community must address the environmental issues that threaten our planet.

We at the American University in Cairo recognize that climate change is a global challenge and solving it will require decisive global action. We believe that institutions such as AUC have a particular responsibility to catalyze environmental action in our communities. As far as we are aware, this series of Carbon Footprint Reports represents the first attempt in the region to measure a university's impact on global climate change. The data we have collected and the expertise we have developed enables us to lessen our environmental impact while simultaneously creating a model for others to measure and address their own impact. This edition is especially important, as it reveals how we as a university can use the challenges of the COVID-19 pandemic to propel AUC's continued pursuit of sustainability.

This report is a product of collaboration among talented scientists, researchers, administrative staff, and facilities operators across campus. Each chapter encompasses a series of Sustainable Development Goals that best represent AUC's commitment to achieving global sustainability.

I thank and commend all those who supported our core research team of Sustainability Director Yasmin Mansour, Sustainability Manager Sahar El Ghandour, Associate Professor of Sustainable Design Khaled Tarabieh, Assistant Professor Sherif Goubran, Architecture Department, and Data Analysis and Report Writing Consultant Sydney Krisanda. We offer this report as a model for future solutions at AUC and at universities across the region as we strive to be trustworthy stewards of the Earth's resources.

Sincerely,


Francis J. Ricciardone
President

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Acknowledgements

This report is the product of continued collaboration among talented engineers, scientists, students, administrative staff, and facility operators across campus. We would like to sincerely thank all those who have supported our core research teams over the past nine years.

The research team would like to express our great appreciation to Wael Taha, Director of Energy Infrastructure System, Office of Maintenance for data collection and analysis, Heba Atteya, Senior Director of Business Intelligence & Data Analysis, Office of Strategy Management and Institutional Effectiveness (SMIE) for survey administration, Ghada Sheba, Director of Creative Services, and Lamia Al Naimi, Assistant Director of Design, Office of Marketing Communication and Public Affairs for cover design, and the Office of Facilities and Operations for data collection and analysis. We would also like to extend thanks to Chemonics Egypt for their expertise in calculating the energy needed to supply water to the University, and to the Shaker Consulting Group for their expertise in calculating carbon coefficients for the electricity that powers the campus. Assistance in proofreading and editing provided by Shereen G. Saafan, Director, Office of the Vice President for Management and Operations, is also greatly acknowledged.

We are particularly thankful for Marc Rauch, founder, and former Director of the Office of Sustainability, who initiated the original Carbon Footprint Report in 2011. Thanks to the Energy and Resource Conservation and Efficiency (ERCE) Task Force for their continuous support in our monthly resource tracking efforts, and to all Office of Sustainability previous presidential associates for their hard work in assembling and standardizing the data collection systems that aid this report.

The Office of Sustainability

The Office of Sustainability is responsible for addressing AUC's environmental challenges, including climate change, resource scarcity, pollution, and waste management, in ways that also improve the University's operations, strengthen its finances, and enhance its reputation.

COVER

The abstract Coronavirus molecule acknowledges the large impact of COVID-19 on AUC's carbon emissions. Within the molecule, the colors of the United Nations Sustainable Development Goals are displayed to highlight AUC's commitment to global sustainability efforts. Each chapter of this report corresponds to various Sustainable Development Goals. The pyramid in the background showcases AUC's commitment to building global initiatives into our sustainability practice. It also represents the volume of greenhouse gases emitted by AUC in Academic Year 2020, which is roughly three times the volume of the three pyramids in the Giza Complex combined.

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LIST OF TERMS

AHU	Air Handling Units
AUC	The American University in Cairo
AY	Academic Year
CO ₂ e	Carbon Dioxide equivalents
COVID-19	Novel Coronavirus
CUP	Central Utility Plant
EEA	Egyptian Electricity Authority
EF	Emissions Factor
EPA	Environmental Protection Agency
EUI	Energy Use Intensity (kWh/m ²)
FAO	Food and Agriculture Organization
FTE	Full Time Equivalent
FY	Fiscal Year
Gas Cool	The Egyptian Company for Refrigeration by Natural Gas
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GWP	Global Warming Potential
HVAC	Heating, Ventilation and Air Conditioning
IPCC	Intergovernmental Panel on Climate Change
kWh	Kilowatt hour
MENA	Middle East and North Africa
MMBTU	Million British Thermal Units
MSCHE	Middle States Association of Colleges and Schools in the United States
MT	Metric Tons
SDG	Sustainable Development Goals
SDS	Sustainable Development Strategy, a part of Egypt Vision 2030
UN	United Nations
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
U.S.	United States
WHO	World Health Organization
VAV	Variable Air Volume

EXECUTIVE SUMMARY

A carbon footprint is a widely accepted indicator of measuring the impact of human activity on global warming. A university's carbon footprint is the annual total of Carbon Dioxide (CO₂) and other significant greenhouse gases emitted into the atmosphere as a result of daily campus activities and operations. Carbon footprints are commonly measured in Metric Tons of Carbon Dioxide equivalents (MT CO₂e). The chief goal motivating the American University in Cairo's (AUC) Carbon Footprint Report is threefold. **First**, we intend to continue developing data and expertise that can be used to reduce AUC's greenhouse gas (GHG) emissions. **Second**, we aim to reiterate the University's commitment to innovation and research in the field of sustainability and to make the University's operations adherently more sustainable. **Third**, we hope to provide a replicable model and a working method that can be adopted by other institutions in the Middle East and North Africa (MENA) region.

This study calculates the carbon footprint for AUC's New Cairo Campus, where most of the University's activities now take place, for the 2019-2020 Academic Year (AY 20) (September 1, 2019, through August 31, 2020). It also provides historical data for each Academic Year since 2011-2012 (September 1, 2011, through August 31, 2012). Thus, this report shows trends in AUC's carbon emissions over nine years.

Throughout the report, the following abbreviations will be used:

AY 20 – (September 1, 2019, through August 31, 2020)
AY 19 – (September 1, 2018, through August 31, 2019)
AY 18 – (September 1, 2017, through August 31, 2018)
AY 17 – (September 1, 2016, through August 31, 2017)
AY 16 – (September 1, 2015, through August 31, 2016)
AY 15 – (September 1, 2014, through August 31, 2015)
AY 14 – (September 1, 2013, through August 31, 2014)
AY 13 – (September 1, 2012, through August 31, 2013)
AY 12 – (September 1, 2011, through August 31, 2012)

The main components of AUC's AY 20 carbon footprint are heating, ventilation and air conditioning (HVAC) and domestic hot water, transportation, electricity for lighting and other equipment (Non-HVAC), natural gas, paper, and water supply. The footprint is presented in **Figure 1** with the MT CO₂e percentage contribution of each category. Based on standardized methodologies, from AY 12-20, AUC's carbon footprint decreased by 8,145 MT CO₂e (from 42,536 MT CO₂e to 34,391 MT CO₂e) or by approximately 19%. The reductions and increases for each major category of emissions from AY 12-20 are as follows.

Reductions	Increases
HVAC (-31%)	Transportation (4%)
Electricity (Non-HVAC) (-29%)	
Paper Use - (40%)*	
Water Supply (-22%)	
Solid Waste Disposal (-42%)	
Fertilizer (-44%)	
Refrigerants (-51%)	

The reductions and increases are discussed in more detail in **Section 1.7** ("Nine-Year Progress Report").

* The Emissions Factor (EF) for paper drastically increased in AY 18. Therefore, the report team retroactively applied the new EF to data from AY 12-17, showing a reduction from AY 12-20. Further explanation is available in **Section 7.2**.

In **Chapters 3 to 13**, we set forth the methodology, data sources, and assumptions that underlay our findings. In **Chapter 14**, we discuss the lessons learned from the impact of COVID-19 on carbon emissions and present a vision forward regarding future campus emissions.

TOTAL AY 20 FOOTPRINT

Academic Year (AY) 20 (September 1, 2019 – August 31, 2020)

Total Emissions: 34,391.3 MT CO₂

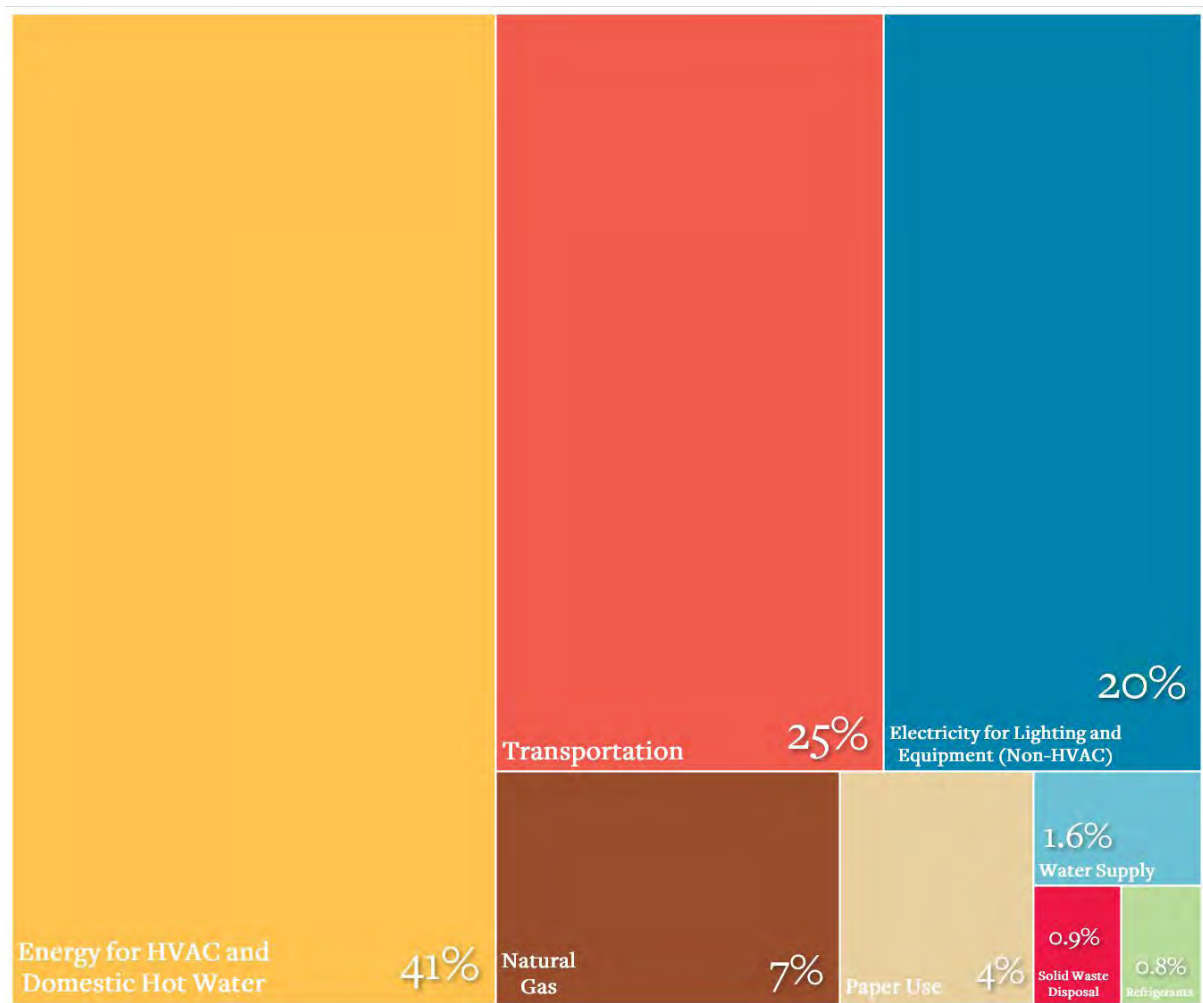


Figure 1. AUC's Carbon Footprint, AY 20. Not pictured is the contribution from Fertilizer use (0.03%).

Box 1. The Main Activities Contributing to AUC's AY 20 Carbon Footprint

Over 85% of AUC's carbon footprint is attributable to three main systems (see **Figure 1**): (1) heating, ventilation, and air conditioning (HVAC) and domestic hot water; (2) transportation; and (3) electricity for lighting and other equipment (Non-HVAC).

HVAC (Heating, Ventilation, and Air Conditioning)

Approximately 41% of the carbon footprint in AY 20 is attributable to HVAC. Unsurprisingly, given that the campus is located in a desert climate where air conditioning is needed more than half the year, the vast majority of these CO₂ emissions result from the consumption of energy for air conditioning. There has been a decrease in HVAC emissions of 31% from AY 12 due to the COVID-19 pandemic which reduced campus consumption. Within the same period, the production efficiency of the CUP has decreased, prompting AUC to use more electricity from the EEA which has a higher production efficiency and lower emissions.

Transportation

Approximately 25% of the carbon footprint in AY 20 is attributable to transportation, with the bulk of transportation emissions stemming from commuting by private car and bus. Commuting has a significant impact on the overall carbon footprint because thousands of AUCians commute daily to AUC's New Cairo Campus. Commuting-related CO₂ emissions have increased steadily since AY 12 largely because of decreased bus ridership and increased car commuting. The reasons for these trends are discussed in **Section 1.7.2 and Chapter 4**. An increase in private car commuting was the principal reason for the increase of AUC's carbon footprint from AY 12 to AY 16. However, emissions from commuting by private car have decreased by 21% from AY 16 to AY 19, likely due to the combination of increased gasoline prices, increased ridesharing, and reduced commuting distances. Emissions from private cars decreased by 44% from AY 16 to AY 20 due to the COVID-19 pandemic with the shift to online teaching and remote working.

Electricity for Lighting and Other Equipment (Non-HVAC)

Approximately 21% of the carbon footprint in AY 20 is attributable to electricity for lighting and other equipment. Other equipment includes office desktop computers, printers, and scanners. As shown in **Chapter 3 and 5**, continuous electricity efficiency measures coupled with the COVID-19 pandemic have led to an overall decrease from AY 12 to AY 20 in non-HVAC emissions.

Refrigerants

Approximately 0.82% of the carbon footprint in AY 20 is attributable to refrigerant use. As discussed in **Section 1.8 and Chapter 6**, refrigerant use and the corresponding CO₂ emissions increased from AY 12 to AY 19 as a result of increased maintenance and an increase in the number of stand-alone air conditioning units. However, when comparing emissions from AY 12 to AY 20 there was a 51% decrease in emissions due to performance upgrades. Further explanation will be presented in **Chapter 6**.

Natural Gas

Approximately 7% of the carbon footprint in AY 20 is attributable to natural gas use. An improved methodology since AY 16 led the report team to find that natural gas for domestic and lab use was underreported from AY 12 to 15. Further explanation of this new method is given in **Chapter 10**.

Water

Approximately 1.6% of the carbon footprint in AY 20 is attributable to supplying water to the campus. As discussed in **Section 1.7.1 and Chapter 8**, the decrease since AY 12 is due to the substitution of treated wastewater for domestic water in irrigating the campus landscaping, as well as to other successful water conservation measures.

Chapter 1

Introduction



1. INTRODUCTION

1.1. Motivation

In 2012, the American University in Cairo (AUC) was one of the first institutions of higher education in the Middle East and North Africa (MENA) region to produce a carbon footprint report in response to the alarming implications of climate change and Egypt's regional energy significance. The University moved most of its operations from its Downtown Tahrir Campus to its New Cairo Campus in the fall of 2008, bringing with it a plethora of sustainability challenges. The New Cairo Campus, a 260-acre structure in a sprawling desert suburb 35 kilometers to the southeast of Cairo, has experienced repercussions of climate change throughout its short existence.

The emergence of the novel coronavirus (COVID-19) has caused drastic shifts in the way we live, work, and learn. The devastating impacts of the pandemic on our global health systems has exacerbated inequalities, highlighting the importance of resilience in the face of shocks. Climate change is a gradually increasing threat to our public health systems, and urgent action is needed in order to curb the unprecedented impacts that further warming of the planet may bring. Due to these facts, and by recognizing the importance of Carbon Dioxide (CO₂) as a greenhouse gas (GHG) and a primary indicator of global warming, AUC publishes a biennial, comprehensive carbon footprint report to assess, monitor and plan for the reduction of its carbon emissions. Carbon footprints are a widely used tool to measure the impact of human activities on global warming, enabling AUC to gauge and compare its emissions with that of other similar institutions and to contribute to global climate action initiatives. The carbon footprint report also allows the University to strengthen its finances by permanently reducing emissions from natural gas, electricity, gasoline, and diesel fuel purchased by third parties while simultaneously investing in its own renewable energy and sustainable development. The University recognizes that it is not immune to nationwide sustainability issues and must implement its own sustainable development plans to better combat climate change. In doing so, AUC acts as a catalyst for change by positioning itself at the forefront of sustainable development in Egypt and the MENA region.

1.2 Global Challenges: Climate Change and Public Health

In the wake of the COVID-19 pandemic, the world faces parallel threats of health, economic, and social crises. For over one year, COVID-19 has plagued the global community, taking the lives of over two million people, and pushing the world into the greatest economic recession since the Great Depression, with an expected 4.2% decline in real GDP per capita (United Nations [UN], 2020). The sanitary crisis has overwhelmed health care systems, halted global supply chains, closed down millions of businesses, and changed almost all aspects of our society.

The world's poorest and most vulnerable populations are disproportionately impacted by the pandemic, exacerbating existing disparities and widening the gap in inequality. People living in poorer areas are often exposed to higher levels of air pollution, compromising respiratory systems, and increasing the health threat of COVID-19. The most vulnerable and poor populations often have the least access to healthcare systems, creating a barrier to ensuring the health and wellbeing of all citizens. The COVID-19 pandemic illustrates how shocks reinforce the inequalities that exist within our systems, undermining our ability to be resilient. The devastating impacts of COVID-19 parallel many of the existing issues within the climate change discussion, providing a wake-up call in the face of increasing crises.

It is widely expected that climate change will exacerbate the likelihood of pandemics around the world (World Health Organization [WHO], 2020). The burning of fossil fuels, such as coal, crude oil, and natural gas, for power generation releases excess CO₂ into the atmosphere and effectively amplifies the Greenhouse Effect¹. The amplification of the Greenhouse Effect creates global warming, or a long-term rise in the average temperature of the Earth's climate system. Disease causing organisms are influenced by environmental factors such as temperature, rainfall, and humidity. Climate change impacts these stressors, throwing off the balance of ecosystems and increasing the risk of disease emergence. Climate change also poses additional risks to our public health by impacting our clean air, safe drinking water, and food supply. It is estimated that avoidable environmental risks cause about one quarter of the global health burden (WHO, 2020). Despite the major societal implications of climate change, actions to reduce greenhouse gas emissions continue to be delayed.

Following the adoption of the Paris Agreement in December 2015, a landmark decision to combat climate change and accelerate the actions and investments needed for a low carbon future, the United Nations called upon the Intergovernmental Panel on Climate Change (IPCC), the leading body for assessing climate change globally, to produce a special report on global warming. Released in October 2018, the IPCC deduced that limiting global warming to 1.5°C above pre-industrial levels would “require rapid, far-reaching and unprecedented changes in all aspects of society” (IPCC, 2018).

Currently, global warming has already surpassed 1°C above pre-industrial levels. Consequences of this warning are evident in the increased frequency and intensity of extreme weather events, localized sea level changes, and lessened sea ice extent. If the world continues to hold a “business as usual” mindset and does not implement sustainable development strategies, global warming will continue to increase past 1.5°C. An unchecked global warming increase above 2°C or beyond would, “increase the risk of long-lasting or irreversible changes, such as the loss of some ecosystems” (IPCC, 2018).

According to the Climate Action Tracker, an organization tasked with monitoring the progress of the countries that have signed the Paris Agreement, the world is likely to surpass 1.5°C warming by 2035 if current government climate policies continue (Climate Action Tracker, 2020). Current policy and pledge trajectories lie above the goal set by the Paris Agreement and there still remains substantial gaps between the policy promises of governments and the actions taken to date. Even under the optimist scenario, which consider the net zero emissions targets of 127 countries, warming projections still surpass the 2°C by 2100 (see **Image 1**).

¹ Greenhouse gases are defined as gases that trap heat within the atmosphere and include Carbon Dioxide (CO₂), Methane (CH₄), Ozone (O₃), Nitrous Oxide (N₂O), Sulfur Dioxide (SO₂), and Hydrofluorocarbons (HFCs). The scientific community focuses research on CO₂ concentrations more than other greenhouse gases due to the gas' sheer abundance in the atmosphere and Global Warming Potential (GWP). The Greenhouse Effect is defined as the process in which radiation from the sun is trapped in the Earth's atmosphere and warms the surface. CO₂ is the main component of the Greenhouse Effect, and without it there would be no sustained life on Earth.

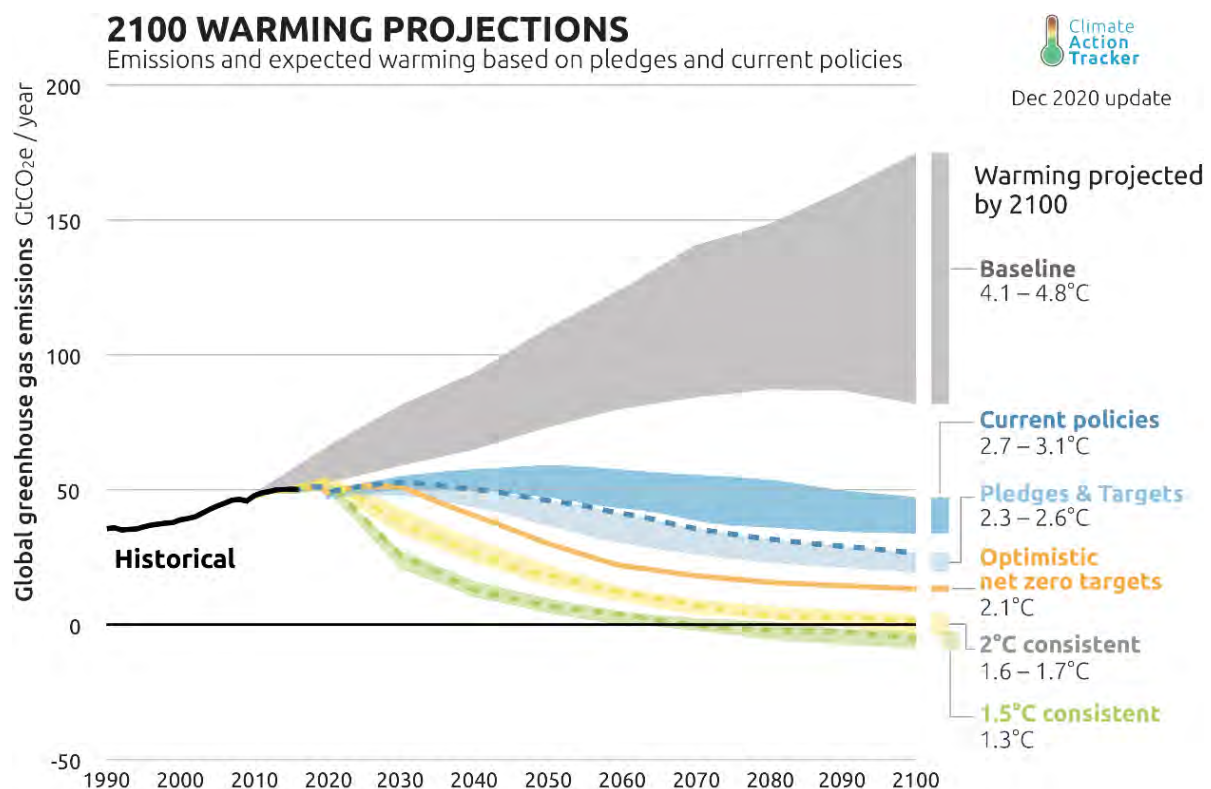


Image 1. 2100 Warming Projections based on global pledges and current policies (Climate Action Tracker, 2020).

1.3 COVID-19 and Carbon Emissions

The COVID-19 pandemic adds both uncertainty and urgency to the issue of global warming. Worldwide, the COVID-19 pandemic forced governments to enact major shutdowns, restrict the movement of people and vehicles, and prevent activities in some of the most energy intensive sectors of society. As economic activity came to halt, many countries around the globe experienced significant environmental impacts on air and water pollution, waste, and greenhouse gas emissions.

Egypt faces many environmental threats, including air pollution, water scarcity and pollution, and food security. Prior to the COVID-19 pandemic, Egypt had a growing economy and a robust fossil fuel energy sector, being the largest non-OPEC (Organization of the Petroleum Exporting Countries) oil producer and the second-largest dry natural gas producer in Africa (KPMG Africa, 2013; African Vault, 2017). The pandemic negatively impacted Egypt's economic growth, as the government halted air travel, closed schools, restaurants, mosques, and churches, and imposed a curfew. By the end of April 2020, the unemployment rate in Egypt increased to 9.2% and most economic sectors were affected (UN Egypt, 2020).

The reduction in economic activity was coupled by significant reductions in gasoline and diesel consumption and electricity use. As a result, the greater Cairo area witnessed improvements in air quality, with an estimated 15% reduction in NO₂, compared to the previous five years. Much of this reduction is attributable to changes in traffic, which contributed to air pollution through releasing particulate matter. The pandemic also contributed negatively to the environment in Egypt, increasing the amount of medical waste as well as municipal and solid waste. Overall, in Egypt, greenhouse gas emissions reduced by at least 4% during the pandemic (Mostafa et al., 2021).

While the measures taken in response to the COVID-19 pandemic varied across countries, there are several global environmental implications to consider. Worldwide, energy use and carbon dioxide emissions decreased in the early lockdowns of the pandemic. Compared to 2019 levels, daily global carbon dioxide emissions fell by 8.8% (Liu, et al., 2020) (see **Image 2a**). This was the largest annual decrease of CO₂ emissions since 1900. However, as restrictions eased as economic activity resumed in the latter half of 2020, carbon emissions rose in many places such as China and Europe (**Image 2b**).

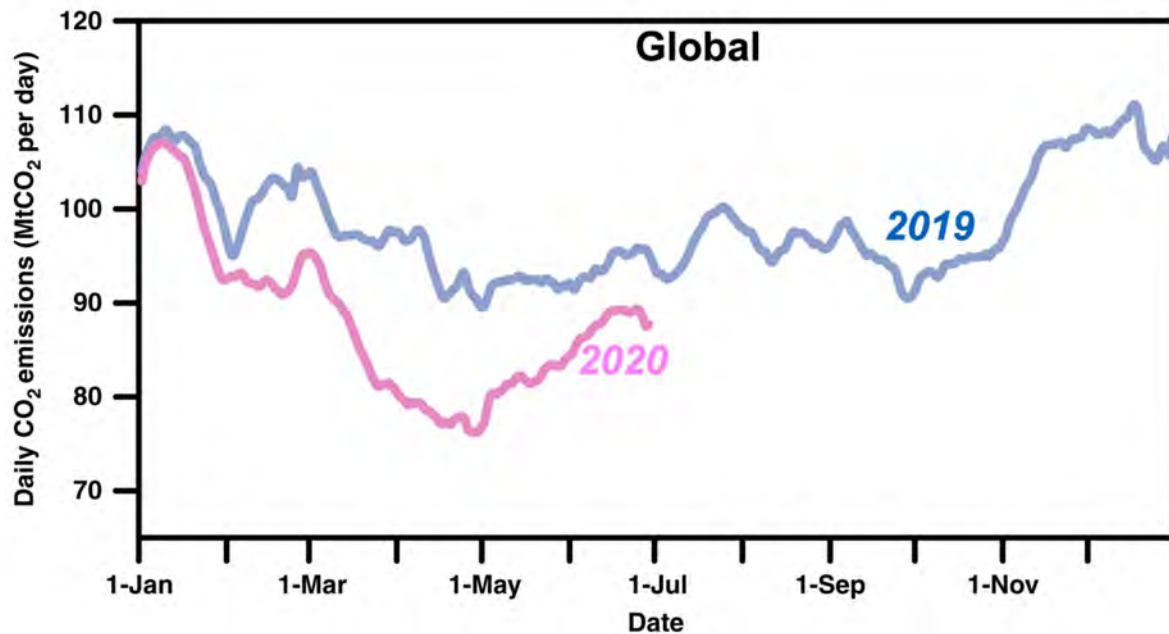


Image 2a. Daily CO₂ emissions in 2019 and 2020 (7-day running mean) (Lui, et al., 2020).

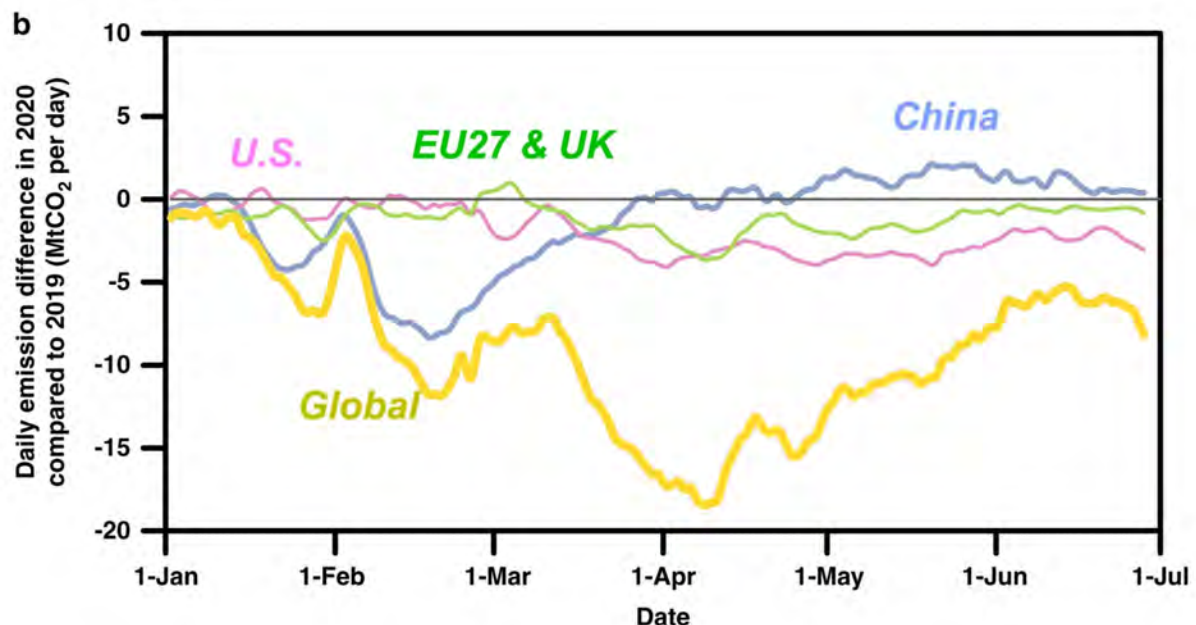


Image 2b. Global emissions aggregate different timing of effects in different regions (7-day running mean) (Lui, et al., 2020).

The effects of the pandemic reveal that far greater change is required to combat the estimated repercussions that climate change will bring. The United Nations Environment Programme (UNEP) estimates that the world needs to cut emissions by 7.6% per year for the next decade to prevent the 1.5 degree warming (UNEP, 2019). In order to achieve this decrease, major transformative changes are needed in energy systems, transportation networks, and building efficiency to reduce the carbon intensity of current economies (Liu, et al., 2020).

The effects of the COVID-19 pandemic present transitional pathways for several global shifts in economic activity and human behavior. At the individual level there is an opportunity to reduce consumption and move towards long-term virtual working. Within the private sector, this is a moment to support innovations in healthcare, education, and environmental initiatives, as well as to create green jobs (Egypt GBC, 2021). For government, encouraging investments in pro-climate action projects and shifting to renewable energy resources should now be of priority. In the face of increasing shocks and crises, building strong and well-resourced health systems and improving environmental determinates of health such as access to clean air, water and sanitation, and safe food and is essential. In order to reach a desirable outcome, collective action between individuals and governments is necessary to redirect our resources to the climate change issue and build a green, healthy, and resilient planet.

1.4. The United Nations Sustainable Development Goals

AUC's attempt to reduce its carbon footprint aligns with many of the Sustainable Development Goals (SDGs) formed by the United Nations in 2015. The outlined 17 goals were adopted by leaders of 193 countries for the achievement of a more sustainable future by 2030. The goals as illustrated in **Image 3** provide a holistic approach to looking at the full spectrum of global challenges, including poverty alleviation, water sanitation, global education, and economic growth (United Nations Development Programme [UNDP], 2015). The year 2020 represents the start of the Decade of Action, a recommitment to the goals outlined by the SDGs five years ago. However, the COVID-19 pandemic has drastically disrupted efforts to achieve the 2030 goals, as the primary focus of nations has shifted to controlling the spread of the pandemic and providing immediate financial relief to aid the economic recession. It is expected that 71 million people will be pushed back into extreme poverty, making it clear that most prior progress made to achieve the goals has either been stalled or reversed by the pandemic (UN, 2020). Now more than ever, achieving the Sustainable Development Goals is pressing, as the principles outlined in the SDGs are key to emerging from the COVID-19 pandemic stronger and more prepared for future shocks. Through collaboration between all sectors of society, we need to accelerate action towards ending extreme poverty and hunger, fighting socio-economic inequalities, addressing climate change, and building a healthier, more resilient planet.

Within this report, each chapter will correspond to various Sustainable Development Goals in an effort to solidify AUC's commitment to global sustainability efforts. This correspondence will examine the critical role of higher education in achieving and implementing the SDGs, which also elevate the information communicated through the carbon footprint report to a national and international scale and provide access to a wider audience outside of the scientific community.

In response to the Sustainable Development Goals, Egypt launched its own Sustainable Development Strategy (SDS) titled, "Egypt's Vision 2030." This strategy addresses key targets and goals in terms of social, economic, and environmental development to be achieved by 2030, and serves as a guiding framework for national development. In 2020, the Government of Egypt (GoE) and the UN in Egypt worked together to develop a plan to mitigate the negative impact of COVID-19 on the development of the SDG's (UN Egypt, 2020). In addition, the UN in Egypt developed the COVID-19 Socio-Economic Response Plan (SERP) to mitigate the socio-economic impacts of the pandemic on the most vulnerable groups in Egypt. The main objects of the plan include economic prosperity, inclusivity of people, alleviating impacts on the planet, and supporting women and girls' access to opportunities. Through collaboration among all sectors of society, Egypt is working towards alleviating poverty and hunger,

combating socioeconomic inequalities, challenging climate change, and ensuring that no one is left behind.

Below is a list of all 17 Sustainable Development Goals along with selected targets to be completed by 2030. Some of the 17 goals have sub-goals that will be completed before 2030. As an institution of higher education attempting to reduce its carbon footprint and create a more sustainable world, AUC contributes directly to the following goals. Most of the goals listed will be linked to at least one of the chapters of the carbon footprint report.



Image 3. The United Nations Sustainable Development Goals

The following information is not our own- it is a reference to the United Nations targets for each Sustainable Development Goal by 2030.

	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day.		Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.		By 2030, ensure women's full and effective participation and equal opportunities for leadership at all levels of decision making in political, economic and public life.
	By 2030, reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination.		By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and reduce the number of people suffering from water scarcity.



By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries.



Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries and improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation,



Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors.



impact reduction and early warning. By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.



By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes.



By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands.



By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.



Develop effective, accountable and transparent institutions at all levels, and ensure responsive, inclusive, participatory and representative decision making at all levels.



By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.



Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed.



By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse.

Note: Only one target is listed for each goal. View the full list of targets and indicators [here](#).

1.5. University Overview

AUC was founded in 1919 and is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools in the United States (MSCHE). Today, it offers American-style liberal arts education as well as graduate programs to Egyptians, students from the MENA region and international study-abroad students. In September 2008, the University moved the bulk of its operations from nine acres of campus on Tahrir Square in downtown Cairo to a brand-new, 260-acre campus in the developing suburb of New Cairo (see **Appendix 1**), with built space almost tripling from 68,000 m² to 203,000 m². Since the 2008 move to New Cairo, the University's activities have expanded to capitalize on its new facilities and to achieve its long-term strategic goals. **Table 1** shows the University's population from AY 12 to AY 20.

Table 1. AUC faculty, staff and student's population, AY 12-20 (AUC SMIE, 2020)									
	AY 12	AY 13	AY 14	AY 15	AY 16	AY 17	AY 18	AY 19	AY 20
Faculty (Full and Part-Time)	843	847	787	787	751	759	750	802	790
Staff	2,838	2,738	2,684	2,496	2,478	2,278	1,976	1,961	2,009
Full-Time Degree	5,214	5,346	5,247	5,404	5,375	5,213	5,093	5,087	5,176
Part-Time Degree	1,289	1,306	1,315	1,503	1,364	1,346	1,360	1,427	1,681
Total	10,184	10,237	10,033	10,190	9,968	9,596	9,179	9,277	9,656
Total Full-Time Equivalent (FTE) Degree Seeking Students ¹	5,830	5,971	5,875	6,092	5,997	5,843	5,722	5,773	5,972

1.5.1 AUC response to COVID-19

COVID-19 is a highly infectious, life-threatening disease declared by the World Health Organization (WHO) to be a global pandemic. COVID-19's highly contagious nature means that contact with others or contact with surfaces that have been exposed to the virus, can lead to infection. Additionally, individuals who may have been infected with COVID-19 may be asymptomatic for a period of time or may never become symptomatic at all. Because of its highly contagious and sometimes "hidden" nature, it is currently very difficult to control the spread of COVID-19 or to determine whether, where, or how a specific individual may have been exposed to the disease. However, AUC took several steps to mitigate the spread of COVID-19 and protect the health of our community members as well as the wider Egyptian public. On March 15th, 2020, the University shifted to online teaching which lasted for the entirety of the spring and summer semesters. The University also canceled events, limited gym, and sports activities, and urged the dorms to evacuate. At the same time, faculty and staff were required to work remotely, only reporting to campus when necessary. For the second half of AY 20 (March 15, 2020 – August 31, 2020) the campus operated with no students and very limited faculty and staff. This left buildings and spaces unoccupied and drastically changed the normal functioning of the AUC campus.

In its preparations to resume the previously planned hybrid model for the spring semester on March 1, 2021, AUC has issued its COVID-19 Campus Guidelines booklet for Spring 2021. While AUC gets ready for an increased level of campus presence, it continues to focus on ensuring the health and safety of its community members throughout the pandemic. While these precautions and requirements may or may not be effective in mitigating the spread of COVID-19, the University is preparing to implement a carefully planned and measured reopening of its campuses based on the best practices of World Health Organization (WHO), the Egyptian Ministry of Health and Population (MoH) and the Centers for Disease Control and Prevention (CDC).

¹ Part-time students represent one half of full-time students

Here is a glimpse of what AUC is doing toward a safe academic and working environment:

- Take a gradual and phased approach for students, faculty, and staff returning to learn, teach and work.
- Mitigate the risk of exposure by requiring AUC community members to regularly monitor their personal health status. Community members should not come to either campus if they are showing symptoms.
- Utilize enhanced cleaning and disinfection protocols across campuses.
- Encourage the entire AUC community and visitors to follow specific guidelines through signage and other communication methods leading to good hygiene practices.

The campus operations team made several adjustments to the systems and services on campus to account for the low occupancy. This included reductions in the use of the air conditioning system, lighting, food service activities, and bus services. The reductions in campus operations greatly impacted AUC's carbon emissions. The components of the University's carbon footprint affected by COVID-19 include HVAC and domestic hot water, transportation, electricity for lighting and other equipment (Non-HVAC), paper use, water supply, solid waste disposal, and natural gas for domestic lab use. The only area not affected by COVID-19 was fertilizer use and landscaping offsets from composting. The impact of COVID-19 on each component of emissions are explained in detail in the remainder of the report.

1.6. AUC Central Utility Plant and Co-Generation

Since approximately 61% of the University's total carbon footprint is attributable to HVAC and domestic hot water, and electricity for lighting and other equipment (Non-HVAC), understanding how these services and utilities are delivered to the New Cairo Campus is vital for understanding our greenhouse gas reporting.

As part of the construction of the New Cairo Campus, AUC entered into a long-term contract with the Egyptian Company for Refrigeration by Natural Gas (Gas Cool) to build and operate an on-campus Central Utility Plant (CUP). The plant, which has a floor area of approximately 5,781 m² (62,226 ft²), produced all of the chilled water used for air conditioning, all of the hot water used for heating, most of the hot water for domestic use, and more than 73% of the electricity used on campus in AY 20. The manner in which each of these services and utilities is produced at the CUP is explained more fully in **Appendix 2**.

AUC's Central Utility Plant is built to be energy efficient in two important aspects. First, the fuel used is natural gas, a relatively clean burning (albeit carbon-based) fuel that is mostly extracted domestically from abundant reserves in Egypt. Second, the plant uses co-generation, a process of capturing and recycling waste heat from electricity generators, to produce nearly half of the hot water used on campus without burning more natural gas. For a more detailed explanation of co-generation at the AUC's Central Utility Plant, see **Appendix 2**.

1.7 Nine-Year Progress Report (AY 12 through AY 20)

From AY 12 to AY 20, the University's carbon footprint decreased by a net amount of **8,145 MT CO₂e** (from 42,536 MT CO₂e to 34,391 MT CO₂e) or by approximately 19%. This net decrease can largely be attributed to the COVID-19 pandemic, which resulted in a major decline of campus operations as students, faculty, and staff shifted to remote working and online teaching.

Most components of the carbon footprint have seen significant reductions when comparing AY 20 to AY 12, including HVAC and domestic hot water, electricity for lighting and other equipment (Non-HVAC), paper use, water supply, solid waste disposal, fertilizers, and refrigerants. Transportation and natural gas saw an increase from AY 12 to 20.

1.7.1 Reduced Emissions from HVAC and Domestic Hot Water, Electricity for Lighting and other Equipment (Non-HVAC), Paper Consumption, Water Supply, and Refrigerants.

HVAC and Domestic Hot Water

This section saw a reduction in emissions compared to AY 12. In AY 20, emissions totaled 14,002 MT CO₂e, while in AY 12 emissions totaled 20,400 MT CO₂e. Therefore, there was a 6,398 MT CO₂e (31%) reduction. In response to the COVID-19 pandemic, the use of the HVAC system in AY 20 was limited to essential locations in AY 20, which explains the reduction in emissions. As of AY 20, AUC's overall Energy Use Intensity (EUI) ranks in the lower half of American universities selected for EUI comparisons operating in hot-dry climates similar to Cairo (see **Section 13.1**).

As shown in **Figure 1** and discussed more fully in **Chapter 3**, HVAC and domestic hot water is a composite category reflecting emissions from electricity used to operate the HVAC system and emissions from energy used for producing chilled and hot water. The single largest sector of energy consumption at AUC is air conditioning. In AY 19, there was a large increase in emissions from chilled water, which can be explained by an increase in average temperatures. More detail is given in **Section 3.2.2**.

Electricity for Lighting and other Equipment (Non-HVAC)

From AY 12 to AY 20, emissions in this category fell by 2,844 MT CO₂e (29%). This is due to electricity conservation measures taken during the COVID-19 pandemic that greatly reduced campus operations and limited lighting to only essential locations.

As discussed more fully in **Section 3.2.2**, the University consumes electricity from two sources: The Central Utility Plant (CUP) and the Egyptian Electrical Authority (EEA). From AY 12 through AY 20, overall electricity consumption at the New Cairo Campus decreased by approximately 21%. This reduction can be partly attributed to consuming a higher amount of electricity from the EEA.

The EEA and CUP have differing production efficiencies due to economies of scale, which affects the fuel mix and subsequent carbon emissions (see **Section 3.2.2**). The EEA produces electricity more efficiently than the CUP, meaning less fuel is needed to produce a kilowatt hour (kWh) of electricity. This means a lower carbon coefficient for electricity supplied by the utility, corresponding with lower CO₂e emissions per kWh for electricity produced by the EEA.

Over the past nine years, the University's electricity conservation measures over the past nine years helped reduced electricity consumption overall. In AY 19, emissions from electricity for non-HVAC increased, mainly due to the expansion of campus operations and campus-wide events. More detail is given in **Section 5.2**.

Paper

From AY 12 to AY 20, there was a 40% decrease in the amount of paper tonnage used by AUC. In AY 18, the Emissions Factor for uncoated paper changed drastically, prompting the research team to retroactively apply the new factor to previous years' data. In AY 20, there was an increase in paper use compared to AY 18 and AY 19. This increase can be attributed to the marketing of AUC's yearlong Centennial celebrations, which occurred before the COVID-19 pandemic. More detail is given in **Chapter 7**.

Water

Emissions from supplying water to campus decreased by 160 MT CO₂e (22%) from AY 12 to AY 20 (see **Chapter 8**). However, water consumption increased by 1% during the same period. The reduction in emissions occurred despite the increase in consumption because AUC switched from domestic (drinking quality) water to treated wastewater to irrigate campus landscaping (see **Section 8.3**). As shown in **Appendix 4** and **Appendix 5**, it requires significantly less energy to bring treated wastewater

to the campus than to bring domestic water. Therefore, less energy consumed results in lower CO₂e emissions. From AY 12 to 20, AUC introduced conservation measures for domestic water and treated wastewater through various water saving projects, such as low-flow showerheads, timed sprinkler systems, and irrigation with solely treated wastewater. In AY 20, the COVID-19 pandemic reduced the need for air conditioning and building water use, further reducing emissions from water.

Refrigerants

From AY 12 to AY 20, emissions from the use of refrigerants decreased by 51% due to equipment and performance upgrades. However, carbon emissions from the use of refrigerants increased by 187 MT CO₂e (33%) from AY 12 to AY 19. This increase in emissions can be explained by the increased need for maintenance of older equipment using refrigerants prior to the AY 20 upgrades. (see **Chapter 6**).

1.7.2. Increased Emissions from Transportation

Transportation

Emissions from transportation increased by 4% from AY 12 to AY 20, with most of the emissions caused by daily commuting by private car and bus to campus. Within the transportation sector, private car commuting accounts for 76% of emissions, and for 19% of overall emissions for the University's footprint. Private car emissions were estimated through the use of online transportation surveys.

Comparing the results of the AY 12 and AY 19 transportation surveys, emissions from bus ridership have decreased steadily, while emissions from private car commuting have risen steadily. Based on the AY 19 transportation survey, in AY 19 almost 9,084 MT CO₂e can be attributed to commuting by private car to the New Cairo Campus. In AY 20, emissions from private car fell to approximately 6,462 MT CO₂e, attributable to the COVID-19 pandemic, which restricted students, faculty, and staff from entering the campus. Emissions resulting from commuting by private car in both AY 19 and AY 20 were higher compared to AY 12, which were estimated to be about 4,890 MT CO₂e.

Despite the recent shift from commuting by bus to commuting by private car, there are long-term reasons for optimism regarding emissions from commuting. First, AUCians have been reducing their daily commuting distances since AY 12 by moving closer to the New Cairo Campus. As discussed in **Section 4.2** and shown in **Figure 8**, more than two-thirds of AUC faculty, staff and students now live in the six Greater Cairo localities closest to the New Cairo Campus. Additionally, with further development of the New Cairo area comes a greater possibility of a new metro line connecting to downtown.

Another commuting option is carpooling, which is more sustainable than driving alone. By having one car do the work of two, three, or even four vehicles, carpooling is a more carbon-efficient way to drive private cars to campus. Based on the results of our online transportation survey, the estimated total kilometers carpooled by the AUC community was 42,363 km in 2019. However, due to low survey respondents, it is predicted that the total amount of kilometers carpooled is much greater than our reported number. The Office of Sustainability is exploring ways to further incentivize carpooling in the AUC community.

Chapter 2

Organization of Report



2. OVERALL METHODOLOGY AND ORGANIZATION OF REPORT

2.1 Reference Carbon Calculator

AUC's emission calculations are premised on the methodology used by Clean Air Cool Planet Carbon Calculator (CA-CP). CA-CP now replaced by the Sustainability Indicator Management and Analysis (SIMAP) is widely used by other universities and is frequently updated. It is an Excel workbook designed to quantify an annual aggregate carbon footprint. Once data is collected, verified, and formatted into proper units for entry, the software calculates emissions of Carbon Dioxide, Methane and Nitrous Oxide, the three most commonly reported greenhouse gas (GHG) emissions (CTCN, 2018). CA-CP is based on workbooks and protocols provided by the Intergovernmental Panel on Climate Change (IPCC), the GHG Protocol Initiative, and the Climate Registry.

AUC's research team discovered that CA-CP's methodology had to be modified to be applicable to AUC. For example, it was necessary to construct a number of emissions factors specific to Egypt, to Cairo, and to processes occurring uniquely at AUC's Central Utility Plant (CUP). Further, CA-CP does not account for carbon emissions attributable to water supply, an issue of critical concern in an arid country like Egypt. Ultimately, AUC's carbon footprint team used CA-CP as a guide for constructing AUC's own emissions calculator. Whenever possible, this report uses categories and methods of analysis similar to those used by CA-CP to facilitate comparisons with the numerous other schools relying on CA-CP.

2.2. Boundaries

This report focuses exclusively on the New Cairo Campus where the bulk of the University's operations now take place. AUC's original Downtown Tahrir Campus, as well as smaller remote or satellite facilities, have consequently been excluded from this analysis.

2.3. Calculating Carbon Dioxide Equivalents (CO₂e)

This report accounts for three of the six main greenhouse gases: Carbon Dioxide (CO₂), Methane (CH₄) and Nitrous Oxide (N₂O). The main unit of measure is Metric Tons (MT) of Carbon Dioxide equivalents (CO₂e) (see **Image 4**), which is the most widely used reporting method. Carbon Dioxide equivalents of CH₄ and N₂O are based on the Global Warming Potential (GWP) of each gas – which compares the amount of heat trapped by a similar mass of CO₂. Over a 100-year period, Methane has a GWP of approximately 28-36, and Nitrous Oxide has a GWP of approximately 265-298 (EPA, 2020). Carbon Dioxide equivalents (CO₂e) are used to express the relative global warming impact of each of the three greenhouse gases through a single unit of measure.

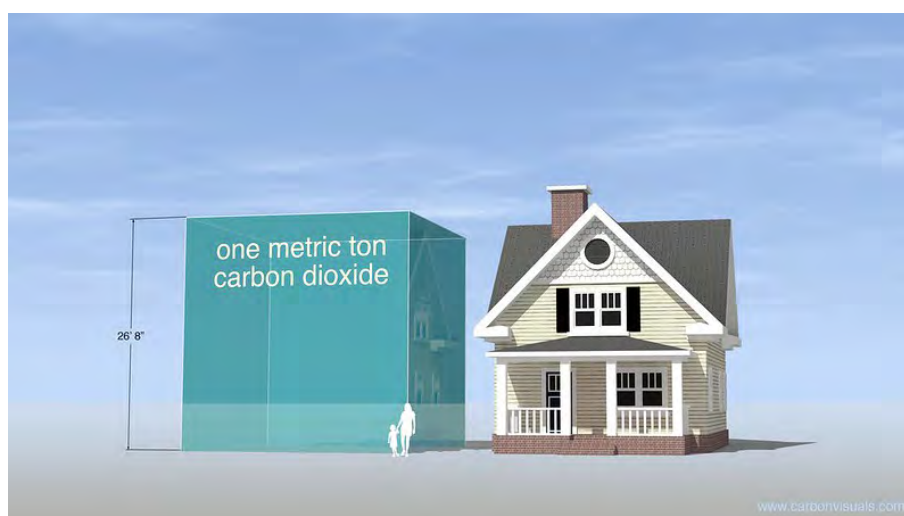


Image 4. At standard pressure and a temperature of 15°C, the density of Carbon Dioxide is 1.87 kg/m³. One Metric Ton of CO₂ occupies 534.8 m³, or the space of a cube 8.12 meters high (26'8") (Carbon Visuals, 2021).

Utilizing the Greenhouse Gas Equivalencies Calculator of the U.S. Environmental Protection Agency (EPA), AUC's total carbon footprint in AY 20 is equivalent to: CO₂ emissions from 17,592,512 liters of gasoline consumed, 3,968 homes' energy use for one year, or 189 railcars' worth of coal burned (EPA, 2020b). Environmentalists and mathematicians alike struggle with conceptualizing what a Metric Ton of Carbon Dioxide looks like. Therefore, it is best to equate the amount of Carbon Dioxide to other more obtainable measurements, such as the amount of coal burned from a particular power plant.

2.4. Improved Methodologies, Data Collection, and Data Analysis

In order to assist readers who are familiar with our previous Carbon Footprint Reports and who wish to accurately compare the AY 20 carbon emissions shown in this report with previous years, Appendix 3 has been added to the current report. It shows carbon emissions broken down by category and recalculated with the most recent methods and data availability. The one exception is natural gas, because we do not currently have access to the data needed to recalculate the natural gas emissions from AY 12 to AY 14.

Since the publication of the Carbon Footprint Report 2017, our team has improved our methodologies, data collection and analysis in a number of aspects. Accordingly, this report contains recalculated carbon emissions for AY 14 in several subcategories. These changes are noted in detail within the affected sections. Notable changes include a re-characterization of transportation survey results, forecasts in place of missing hot water data, and a new methodology of calculating natural gas emissions.

2.5. Organization of Report

Chapters 3 through 11 of this report analyze the number of Metric Tons of CO₂e resulting from each of the principal activities at AUC in descending order of emissions: HVAC and domestic hot water (**Chapter 3**); transportation (**Chapter 4**); electricity for lighting and other equipment (Non-HVAC) (**Chapter 5**); natural gas (**Chapter 10**); paper use (**Chapter 7**); water supply (**Chapter 8**); refrigerants (**Chapter 6**); solid waste disposal (**Chapter 9**); and fertilizer (**Chapter 11**). The detailed analysis of emissions in **Chapters 3 through 11** is followed in **Chapter 12** by an analysis of carbon sequestration from campus landscaping and composting. **Chapter 13** compares AUC's energy use intensity (EUI) and emissions per FTE student to those of American universities in similar climates. **Chapter 14** then discusses the lessons learned from the impact of COVID-19 on carbon emissions, presents a vision forward regarding future campus emissions, and suggests specific recommendations for reducing AUC's carbon footprint. Through certain chapters, where applicable, there are individual recommendations tailored to readers to reduce their own carbon footprint.

Chapter 3

HVAC and Domestic Hot Water

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
ECONOMIC GROWTH



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



10 REDUCED
INEQUALITIES



11 SUSTAINABLE CITIES
AND COMMUNITIES



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



14 LIFE
BELOW WATER



15 LIFE
ON LAND



16 PEACE, JUSTICE
AND STRONG
INSTITUTIONS



17 PARTNERSHIPS
FOR THE GOALS



3.1. Summary

As shown in **Figure 1**, roughly 41% of AUC's carbon emissions in AY 20, or **14,002 MT CO₂e**, were attributable to HVAC and domestic hot water. Natural gas, electricity, and water in various processes at AUC's Central Utility Plant (CUP) produce these services (see **Appendix 2**). Electricity is used to power pumps which circulate both chilled water for air conditioning and hot water for heating and domestic use throughout campus. Electricity also powers Air Handling Units (AHU), Variable Air Volume (VAV) units, and other equipment required for the HVAC system. Electricity used for lighting and other equipment (non-HVAC) is discussed in **Chapter 5**.

Air conditioning is AUC's single largest consumer of energy. Absorption chillers at the CUP use natural gas to produce chilled water for air conditioning. The waste heat given off by the absorption chillers is removed by a circulating water system that releases the waste heat from five cooling towers through evaporation. In AY 20, these cooling towers alone accounted for approximately 12% of AUC's total water use (see **Section 8.2**).

Hot water for heating and domestic hot water is produced in one of two ways. Whenever possible, hot exhaust fumes from gas-fired electricity generators are used to heat water in heat-recovery boilers (a process known as co-generation, described in **Section 3.3.2** and **Appendix 2**). When the heat-recovery boilers are not sufficient for producing the volume of hot water needed, additional hot water is produced in conventional, natural gas-fired boilers.

3.2. Electricity for HVAC

3.2.1. Emissions

In AY 20, carbon emissions from electricity consumption totaled **15,637 MT CO₂e** overall (see **Figure 2**). The University emitted an estimated **11,421 MT CO₂e** through the consumption of electricity produced at the Central Utility Plant (CUP) and an additional **4,216 MT CO₂e** through the consumption of electricity supplied by the Egyptian Electricity Authority (EEA). An estimated 55% or **8,600 MT CO₂e** of the total emissions was due to the operation of the HVAC system. The basis for attributing carbon emissions to HVAC and non-HVAC operations respectively is discussed in **Appendix 2**.

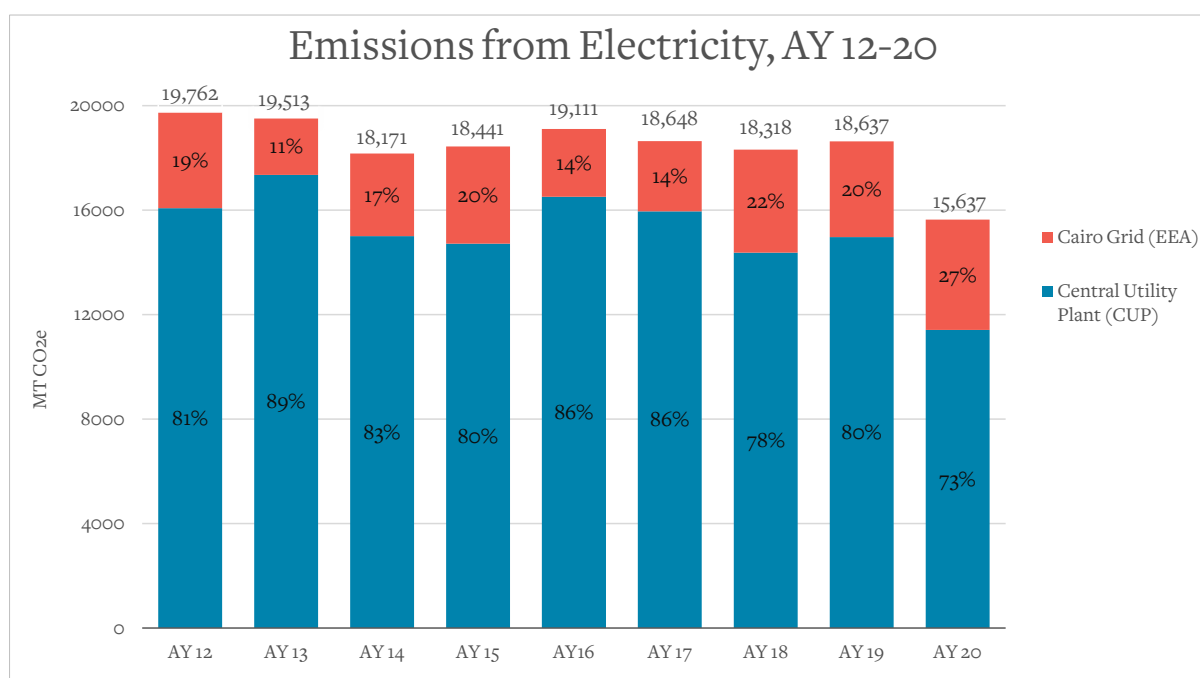


Figure 2. Breakdown of emissions from electricity purchased from the EEA and emissions from electricity generated in AUC's Central Utility Plant (CUP).

3.2.2. Explaining the Trend in Energy Consumption and Emissions

In AY 20, the University consumed 18,141,200 kWh of electricity from the Central Utility Plant (CUP) and 8,858,080 kWh from the Egyptian Electricity Authority (EEA). In AY 19, the University consumed 24,534,800 kWh of electricity from the CUP and 7,703,520 kWh from the EEA. In AY 18, the University consumed 24,204,000 kWh of electricity from the Central Utility Plant (CUP) and 7,629,600 kWh from the Egyptian Electricity Authority (EEA). From AY 18 to AY 19, consumption from the CUP increased by 1% and consumption from the EEA increased by 1%, as well. From AY 19 to AY 20, consumption from the CUP decreased by 26% and consumption from the EEA increased by 14%. *In sum, from AY 18 to AY 19, electricity consumption from the CUP increased, but then decreased from AY 19 to AY 20.; while from AY 18 to AY 20, electricity consumption from the EEA has been steadily increasing.*

In AY 20, the University emitted **11,421 MTCO₂e** from electricity consumption from the CUP and **4,216 MTCO₂e** from electricity consumption from the EEA. In AY 19, the University emitted **14,970 MTCO₂e** from electricity consumption from the CUP and **3,667 MTCO₂e** from electricity consumption from the EEA. In AY 18, the University emitted **14,378 MTCO₂e** from electricity consumption from the CUP and **3,940 MTCO₂e** from electricity consumption from the EEA. From AY 18 to AY 19, emissions from the CUP increased by 4% and emissions from the EEA decreased by 7%. From AY 19 to AY 20, emissions from the CUP decreased by 24% and emissions from the EEA increased by 15%. *In sum, from AY 18 to AY 19, emissions from electricity consumption from the CUP increased but then decreased from AY 19 to AY 20; while from AY 18 to AY 20, emissions from electricity consumption from the EEA have been steadily increasing.*

From the Base Year AY 12 to AY 20, AUC decreased its electricity consumption overall by 27%. Yet, during the same period, carbon emissions from electricity consumption fell by 21%. The decrease in consumption and emissions is illustrated in **Figure 3**.

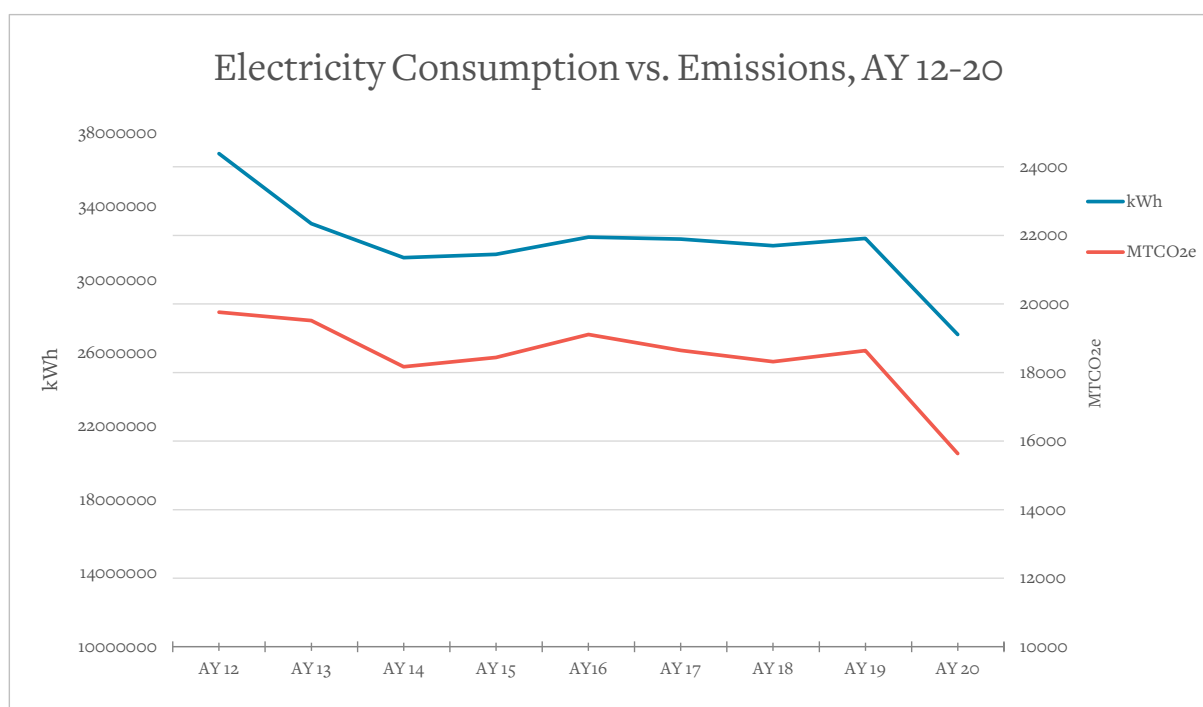


Figure 3. Electricity consumption vs. resulting carbon emissions.

To track the increase in electricity consumption and emissions between AY18 and AY19, it requires the consideration of two key factors: monthly temperatures and campus operations. In AY 19 there were six months with average temperatures above AY 18 temperatures. Some of the warmest months of the year that saw temperature increases are from June to November. These months are the highest-energy consuming months of the year because of the increased need for air conditioning. In AY 19,

there was also an expansion of campus operations due to campus-wide events and a fully occupied campus. Therefore, we can partially attribute the increase in energy consumption to the increased air condition during warm months and the expansion of campus operations.

The COVID-19 pandemic had a large impact on the decrease in carbon emissions from HVAC in AY 20. The relative consumption from AY 18 to AY 20 decreased by 15% from 31,833,600 kWh to **26,999,280 kWh**, respectively. The reduction in electricity consumption is likely due to reducing electricity and HVAC in unoccupied spaces. In March 2020, the University shifted to remote working and online teaching in response to COVID-19. As a result, the use of the HVAC system was limited to essential locations including the Rare Books Library, IT rooms, and chemical labs and storage. HVAC operations in all non-essential locations were stopped, including the campus swimming pool. AUC effectively monitors its energy usage through a Building Management System (BMS) that controls internal comfort conditions in classrooms and buildings.

Following the institutional guidelines around the COVID-19 pandemic, the ventilation and fresh air use in the buildings on campus increased. Normally, the minimum percentage of fresh air used to regulate building temperatures is 10%, while the use of return air is 90%. Because of COVID-19, the percentage of fresh air increased to 40%, while the use of return air decreased to 60%. This action was one of the many operational changes the University implemented to prioritize the health and safety of its campus members and prevent the spread of COVID-19.

Power plants associated with the EEA operate at a higher efficiency than the CUP, most likely due to economies of scale (the utility scale vs. the generating capacity of the CUP) and the use of higher carbon-emitting, but more efficient, fuel mix. Though AUC benefits from the lower price of electricity generated by the CUP, it shifted more of its electricity consumption in AY 20 to the EEA. This was in part to lower overall emissions, but it was also due to the lower production efficiency of the CUP generators, which propelled the University to retrieve a higher percentage of its electricity need from the EEA in AY 20.

The differing production efficiencies between the CUP and the EEA, coupled with a higher dependency on the EEA for electricity production explains the reduction in emissions. Higher efficiency means that less fuel is needed to produce a kWh of electricity, which in turn translates into lower CO₂e emissions per kWh of electricity consumed.

In the Base Year AY 12, the production efficiency of the EEA was 43.10%, and the production efficiency of the CUP was 37.03%. According to the 2019 EEA Report, EEA efficiency increased to 43.64% in AY 19 and AY 20. Readings from the CUP for AY 19 show that efficiency dropped from the Base Year AY 12 to 33.13%. In AY 20, the efficiency of the CUP decreased further to 32.11%. This means that in both AY 19 and AY 20, producing one kWh of electricity emitted more carbon than producing one kWh of electricity in the Base Year AY 12 (see **Figure 4**).

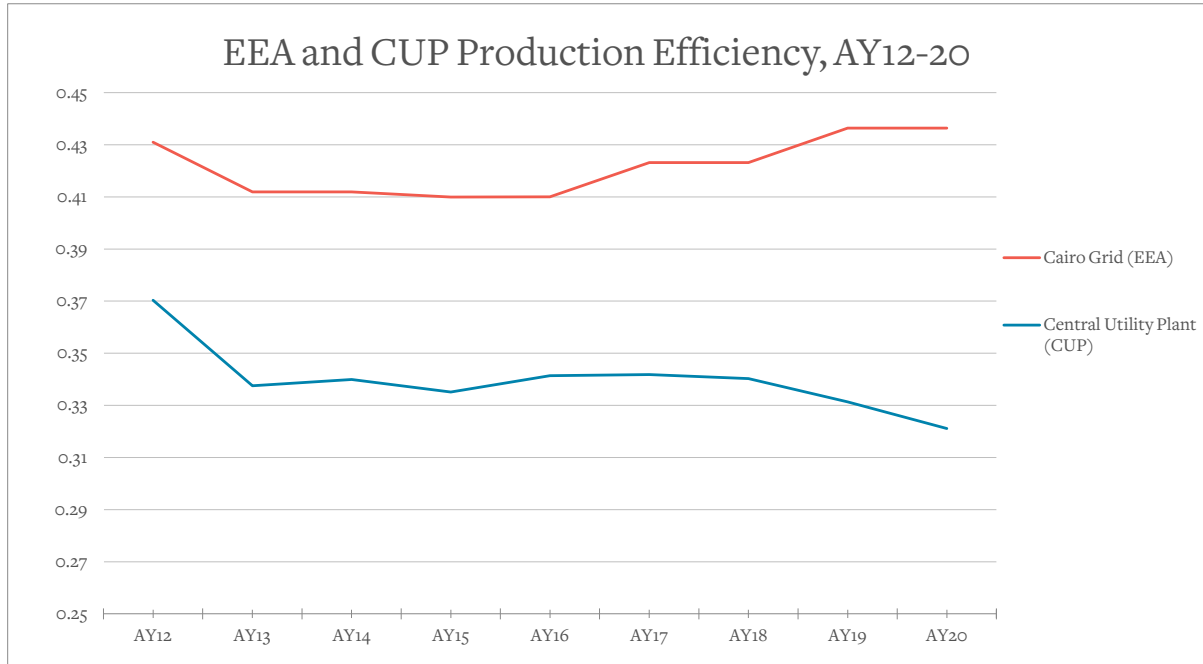


Figure 4. Comparison of EEA and CUP production efficiencies.

The distribution of electricity consumption from our two sources also changed from AY 18 to AY 20. In AY 18 AUC obtained 78% of its electricity from the CUP and 22% from the EEA. In AY 19, AUC obtained 80% of its electricity from the CUP and 20% from the EEA. In AY 20, AUC obtained 73% of its electricity from the CUP and 27% from the EEA. From AY 18 to AY 20, there has been both a decrease in consumption as well as a lessened reliance on the CUP, as illustrated in (Figure 2).

3.2.3. Methodology

Egyptian Electricity Authority

The emissions factors for the energy inputs used to generate electricity are required to calculate the EEA Emissions Factor (EF). Emissions factors are recalculated on a yearly basis to account for fuel and/or efficiency changes.

Cairo Zone Fuel Mix

Year	Natural Gas (%)	Fuel Oil (%)
AY 12*	83.3	16.2
AY 13 – AY 14**	78.3	21.7
AY 15 – AY 16***	73.6	26.4
AY 17 – AY 18****	78.8	21.2
AY 19 – AY 20 *****	92.8	7.2

Cairo Zone Efficiency of Electricity Production

Year	Efficiency (%)
AY 12*	43.10
AY 13 – AY 14**	41.19
AY 15 – AY 16***	41.00
AY 17 – AY 18****	42.32
AY 19 – AY 20 *****	43.64

* (Egyptian Environmental Affairs Agency 2012), ** (Egyptian Environmental Affairs Agency 2014), *** (Egyptian Environmental Affairs Agency 2016), **** (Egyptian Environmental Affairs Agency 2017), ***** (Egyptian Environmental Affairs Agency 2019)

AUC Central Utility Plant

The CUP runs on 100% natural gas. Below is the efficiency of the CUP from AY 12 to AY 20.

For calculating the Emissions Factor (EF) for the Central Utility Plant's electricity, residual fuel oil was excluded since the plant operates solely on natural gas.

Year	Efficiency (%)
AY 12	37.03
AY 13	33.75
AY 14	33.99
AY 15	33.51
AY 16	34.14
AY 17	34.18
AY 18	34.03
AY 19	33.13
AY 20	32.11

3.2.4. Data and Sources

Data on electricity consumption was provided by AUC's Office of Facilities and Operations based on monthly readings of AUC's digital meters.

3.2.5. Emissions Factors

Source	Mass Emissions (kgCO ₂ e/kWh)
Egyptian Electricity Authority (EEA)	0.6102
Central Utility Plant (CUP)	0.4760

3.3. Chilled and Hot Water

3.3.1. Emissions

In AY 20, the University emitted **5,402 MT CO₂e** through the consumption of chilled water for air conditioning and the consumption of hot water for heating and domestic hot water. Of the total emissions, **3,979 MT CO₂e** (74%) can be attributed to the consumption of chilled water and **1,422 MT CO₂e** (26%) to the consumption of hot water (see **Figure 5**) AUC decreased its emissions from hot and chilled water consumption by 30% over the period AY 13-20.

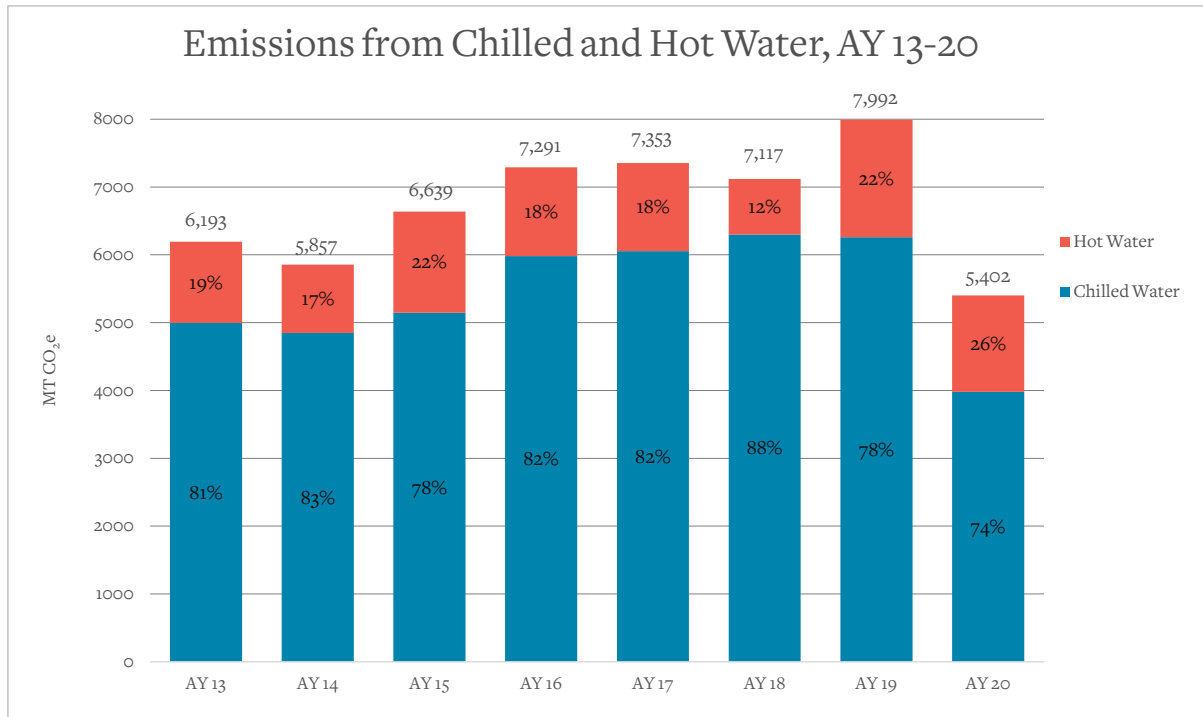


Figure 5. Emissions from chilled and hot water consumption.

3.3.2. Emissions Avoided Through Co-Generation

As discussed in Section 1.5, AUC's Central Utility Plant (CUP) uses two gas-fired electricity generators to feed hot exhaust fumes to heat recovery boilers that produce hot water. In AY 20, approximately 32% of the hot water consumed was produced by co-generation; thus, AUC did not burn additional gas. This saved an estimated 2,933,912 kWh of heat energy and **682 MT CO₂e** compared to if the same amount of hot water had been produced by conventional, gas-fired boilers.

3.3.3. Consumption

In total, the University consumed energy equivalent to 22,042,024 kWh in AY 20 for chilled and hot water. Of this total, 15,915,242 kWh were attributable to chilled water and 6,126,783 kWh were attributable to hot water.

3.3.4. Methodology

We constructed emissions factors for the production of chilled water by absorption chillers and hot water by conventional, gas-fired boilers at the Central Utility Plant (CUP).

3.3.5. Data Sources

We obtained data on the chilled and hot water use from AUC's Office of Facilities and Operations monthly meter readings.

3.3.6. Emissions Factors

Source	Mass Emissions (kgCO ₂ e/kWh)
Hot Water Production (CUP)	0.2324
Hot Water Production (Kahraba)	0.2242
Chilled Water Production (CUP)	0.2500
Auxiliary Electricity	0.5871

Recommendations to lower your energy demand:

- Turn off heating, ventilation, and air conditioning (HVAC) systems when leaving a room.
- Close all windows and doors when HVAC systems are in use.
- Do not set an air conditioning unit to below 24 °C in the summer or above 21 °C in the winter.
- Wear clothing suitable for weather conditions. If it is cold, put on more layers instead of turning up the thermostat.

For additional suggestions, please email us at sustainability@aucegypt.edu or go to www.aucegypt.edu/about/sustainable-auc for more information.

Chapter 4

Transportation

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
ECONOMIC GROWTH



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



10 REDUCED
INEQUALITIES



11 SUSTAINABLE CITIES
AND COMMUNITIES



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



14 LIFE
BELOW WATER



15 LIFE
ON LAND



16 PEACE, JUSTICE
AND STRONG
INSTITUTIONS



17 PARTNERSHIPS
FOR THE GOALS



4.1. Summary

Transportation activities at AUC resulted in approximately **8,562 MT CO₂e** in AY 20. As shown in **Figure 1**, transportation represents approximately 25% of AUC's carbon emissions. The largest percentage of transportation emissions is attributable to daily commuting to and from AUC New Cairo campus by private car and bus, accounting for approximately **7,243 MT CO₂e**. The remainder of transportation emissions came from three sources: business air travel accounted for **965 MT CO₂e**, trips made by the University fleet accounted for **332 MT CO₂e**, and sponsored field trips accounted for **22 MT CO₂e**.

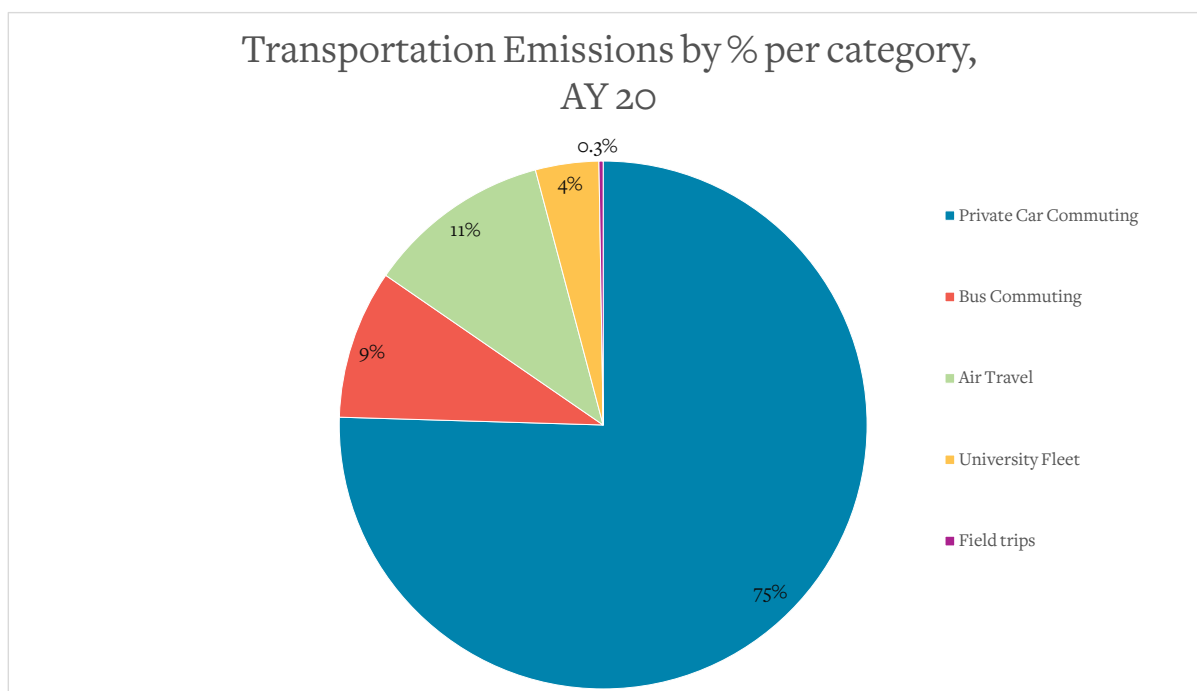


Figure 6. Total transportation emissions.

Cairo is a sprawling city with neighborhoods spreading out for more than an hour in each direction from downtown. The New Cairo Campus is located approximately 35 km from the center of the city, thus it is not surprising that approximately 21% of AUC's total carbon footprint is attributable to commuting by private car and bus.

To arrive at approximate emission data related to commuting, the Office of Sustainability worked with AUC's Office of Strategy Management and Institutional Effectiveness (SMIE) to administer annual online transportation surveys. The data presented in this chapter comes from those surveys. More insight into the methodology can be found in **Section 4.2.3**.

The second biggest source of transportation emissions, business air travel, refers to faculty and staff who fly to destinations around the globe for meetings, conferences, and research. Business air travel accounted for around 3% of AUC's total carbon footprint in AY 20. The University also operates a fleet of cars, vans, minibuses, and light duty trucks for use by AUC personnel. The operation of the University fleet accounted for 1% of AUC's total carbon footprint in AY 20. Finally, the University sponsors student field trips for educational purposes, generally by bus, to destinations within Egypt. In AY 20, these trips accounted for 0.06% of AUC's total carbon footprint.

4.2. Commuting by Private Car, Bus and Carpooling

4.2.1. Emissions

In AY 20, commuting to and from AUC New Cairo Campus by private car and bus contributed an estimated **7,243 MT CO₂e** of carbon emissions to AUC's total carbon footprint, which represents a 9% increase in emissions from the Base Year AY 12 (see **Figure 8**). Using the same process as in Carbon Footprint Report 2019, we cite the primary reason for the increase in emissions since AY 12 as being a pronounced shift from commuting by bus, a fuel-efficient mode of transportation, to commuting by private car, which is neither fuel-efficient nor carbon efficient.

Based on our surveys, AUC's faculty, staff and students appear to be moving closer to the New Cairo Campus. In March 2012, the first year of data collection, only about 12% of the respondents to AUC's online transportation survey lived in New Cairo and Al-Rehab, the two localities closest to the New Cairo Campus, while in November 2016 approximately 24% of the respondents lived in New Cairo and Al-Rehab. In the newest transportation survey taken in Spring 2019, approximately 39% of the respondents lived in New Cairo and Al-Rehab. This increase is positively correlated with the development of the surrounding neighborhood. According to the same survey in Spring 2019, approximately 68% of respondents live in the six greater Cairo localities closest to the New Cairo Campus (see **Figure 7**). On average, in order to reach the New Cairo Campus and return home in the evening, AUCians traveled a daily average of 70 km round trip in AY 19 and AY 20.

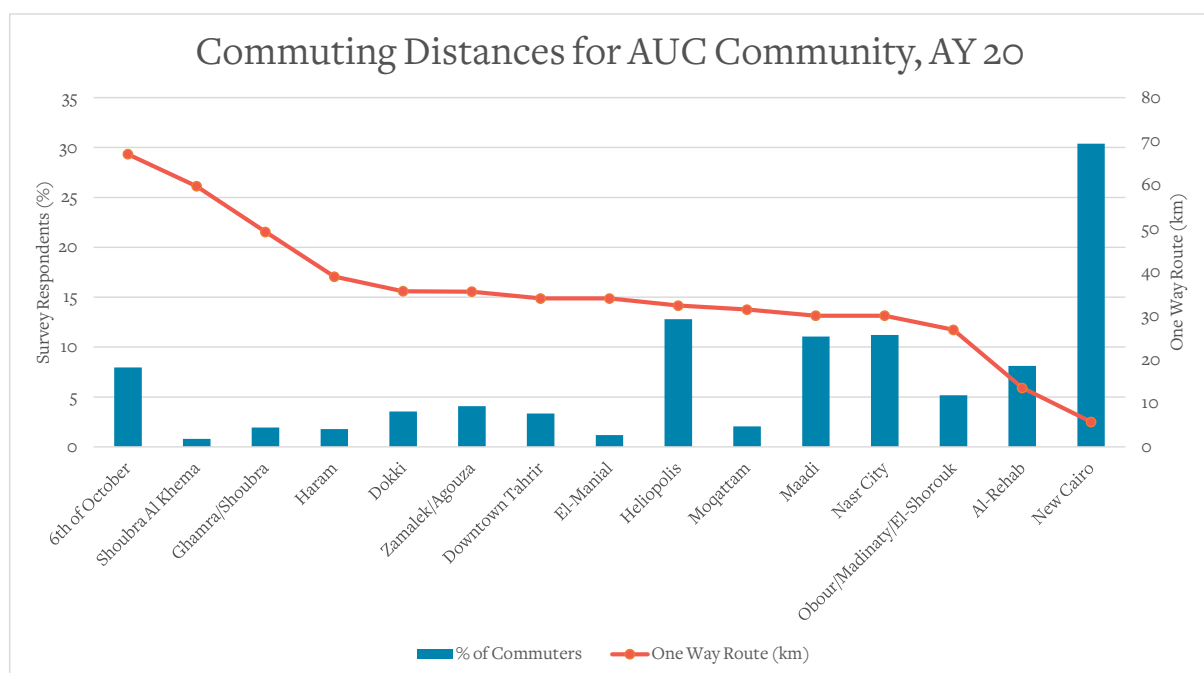


Figure 7. Commuting routes and distances for the AUC Community.

AUC operates a bus service for AUC community members to reach the campus by way of 13 separate routes. Apart from this service, there is limited public transportation connecting the New Cairo Campus to Greater Cairo. Currently, the only option is a city bus with limited times and low ridership. Most commuters who do not make use of the bus service reach the New Cairo Campus by private car.

In AY 19, the most recent survey year, approximately 47% of students, faculty, and staff reported usually taking the bus to campus, in comparison to 49% in AY 17, 57% in AY 15, and 68% in AY 12. In AY 19, approximately 44% of students, faculty, and staff reported usually commuting to campus by private car in comparison to 39% in AY 17, 45% in AY 15, and 30% in AY 12. From AY 12-19, the total percentage of private car commuters increased by 51% and bus ridership decreased by 31%.

The cutbacks in the bus system in June 2014 may have played a role in decreased bus usage. In an effort to reduce the financial burden of maintaining a heavily subsidized university bus system, the frequency and number of routes and the hours of service were decreased. AUC decided to cut the number of bus routes from 16 to 13, which may have left students, faculty, and staff from those affected areas more inclined to travel by private car. Not to mention, the increased incidence of AUCians living in the New Cairo area may further explain the increase in private car commuting. The development of New Cairo and the continuous growth for business and housing impacted the population dynamics of the area.

In AY 19, bus service to and from campus for student, faculty, and staff accounted for 2,048,140 km traveled. Emissions from this bus service are estimated to be **1,047 MT CO₂e**. Of the total, full-size diesel coaches produced approximately **659 MT CO₂e** with the remaining **389 MT CO₂e** produced by minibuses (see **Figure 8**). In AY 20, bus service to and from campus for faculty, staff, and students accounted for 1,629,831 km traveled. Emissions from this bus service are estimated to be **781 MT CO₂e**. Of the total, full-size diesel coaches produced approximately **471 MT CO₂e** with the remaining **310 MT CO₂e** produced by minibuses (see **Figure 9**). In March 2020, the University shifted to online teaching and remote working in response to the COVID-19 pandemic. As a result, the AUC bus service reduced its operations explaining the large decrease in bus service emissions for AY 20.

In AY 19, those commuting by private car drove an estimated 42,627,243 km with a total emissions of 9,084 MT CO₂e, which represented 90% of all transportation emissions. In AY 20, those commuting by private car drove an estimated 30,325,493 km; this figure comprises of about 69% of km traveled by students and 31% of km traveled by faculty and staff. We estimated that emissions from private car commuting are **6,426 MT CO₂e**, or 89% of all emissions attributable to commuting in AY 20 (see **Figure 8**). Of the private car commuting total, students account for **4,439 MT CO₂e** with the remaining **2,023 MT CO₂e** attributable to faculty and staff.

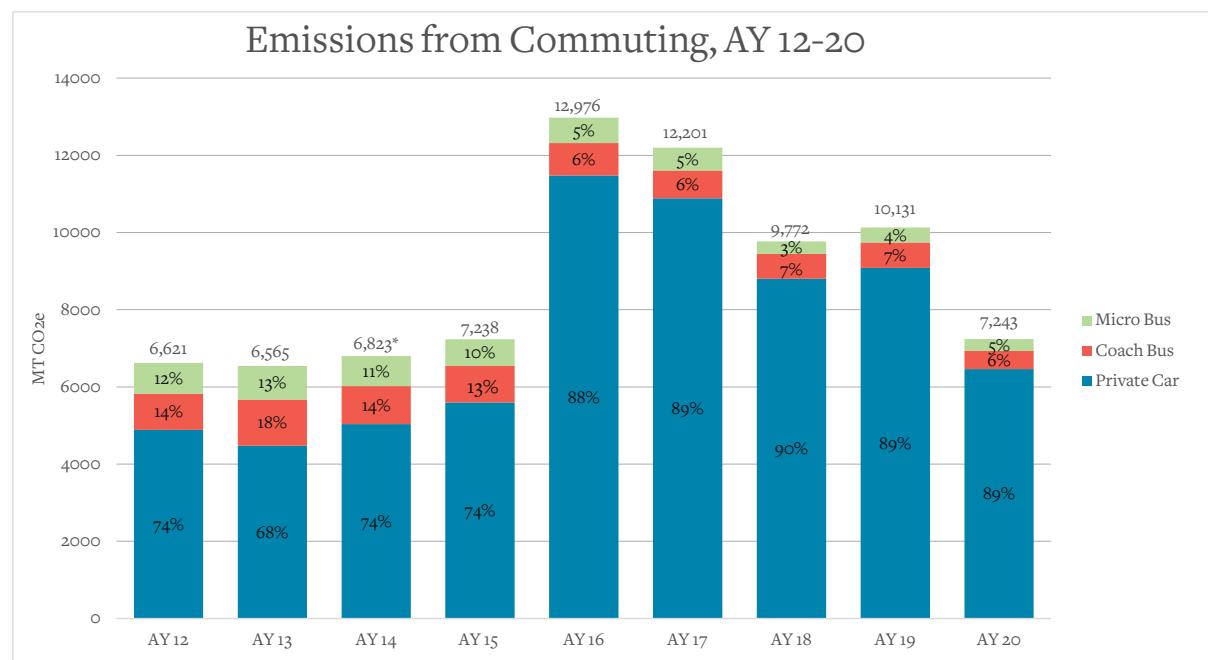


Figure 8. The total commuting emissions consist of three sources: full-size coach buses, minibuses and private cars.

*Approximated number, explained in detail in **Section 4.2.3**

Carpooling is a well-known method for reducing the number of cars on the road, air pollution and carbon emissions. It essentially enables one car to do the work of multiple cars and also helps to reduce the traffic congestion that is ubiquitous in Greater Cairo. In late AY 12, the University adopted

a policy of waiving on-campus parking fees for carpoolers. While exact rates of carpooling are not available, we can make an informed estimate that carbon emissions from transportation would have been about 6% higher without the practice of carpooling.

4.2.2. Methodology

The AUC transportation website displays the 13 current bus routes on Google Maps and calculates trip lengths. The number of times each route was driven during each year was multiplied by the route's trip length to estimate the annual kilometers traveled by full-size diesel coach buses and minibuses. These kilometer totals were then multiplied by the pertinent emissions factors provided in **Section**

4.2.5.

AUC's Office of Transportation Services collects bus trip data daily, providing more accurate measurements of distances traveled. Even so, the results presented for AY 12 through AY 20 are estimates since there are still some gaps in the data that require interpolation from the known data.

Total annual car commuting distances were adjusted for carpooling in accordance with survey responses and further adjusted for lower commuting populations during the winter session, summer session and holidays. In AY 20, estimates were further adjusted to account for the impact of the COVID-19 pandemic on the commuting campus population. The adjusted kilometer totals were then multiplied by the pertinent emissions factors provided in **Section 4.2.5.**

4.2.3. Clarification of Private Car Methodology

The portion of emissions attributable to commuting by private car is estimated with the help of a campus-wide transportation survey. The survey is administered by the Department of Strategy Management and Institutional Effectiveness (SMIE) and asks voluntary participants about their chosen methods of transport and routes taken to and from AUC's New Cairo Campus.

We have accurate survey data for every academic year, excluding AY 14, AY 18, and AY 20. The Office of Sustainability was not able to administer a survey within the calendar parameters of AY 14. For the Carbon Footprint Report 2015, the AY 15 survey was used as proxy data for AY 14. The research team deemed it acceptable to use proxy data because there were no significant enrollments or structural differences in transportation to campus between AY 14 and AY 15. To improve emission calculations, the research team of the Carbon Footprint Report 2017 approximated AY 14 private car commuting retroactively. Noting that the shift away from commuting by bus and towards commuting by private car has been sustained since AY 12, the team assumed the percentage of emissions attributable to private cars in AY 14 would be greater than AY 13. To obtain a figure, the team simply took the average between private car emissions in AY 13, which was 4,476 MT CO₂e, and private car emissions in AY 15, which was 5,598 MT CO₂e. Apart from the total figure, the data that was labeled as "AY 14" in the Carbon Footprint Report 2015 has been relabeled as "AY 15" for purposes of accurate comparison of recent trends in the current section.

In the Carbon Footprint 2019, the research team discovered that the AY 18 transportation survey was inaccurate and was therefore not used. The transportation survey had a small sample size, which grossly underestimated the percentage of faculty, staff, and students commuting by private car to the New Cairo Campus from the 13 designated locations. The research team decided to utilize the responses collected within the AY 17 survey and combined this data with the population makeup of AUC in Spring 2018. The population of the University refers to the number of faculty, staff, and students employed or enrolled of the University in a given semester.

In Spring 2019, a new transportation and carpooling survey was administered. The response rate was low, however the research team deemed more accurate than continuing to rely on old survey data. Due to the COVID-19 pandemic, the Office of Sustainability could not administer a survey in AY 20. Therefore, both AY 19 and AY 20 use the Spring 2019 survey. In AY 20, the research team combined

the Spring 2019 survey responses with the population makeup of AUC in Spring 2020. During the COVID-19 pandemic, the University shifted to online teaching and remote working, greatly reducing the percentage of the population commuting to the campus. Some assumptions were made in order to estimate commuting emissions during COVID-19. Typically, it is estimated that the campus is at 100% capacity in the fall and winter semesters, and 30% capacity in the summer. Using campus gate data, we estimated the campus to be at 3% capacity during the months of COVID-19 (March 15, 2020 – August 31, 2020). The decrease in people coming to campus greatly reduced the campus emissions from commuting in AY 20.

4.2.4. Data Sources

Data on bus commuting was provided by the AUC's Office of Transportation Services, and data on private car commuting was acquired through online transportation surveys administered by the Department of Strategy Management and Institutional Effectiveness (SMIE).

4.2.5. Emissions Factors

Source	Mass Emissions (kgCO ₂ e/km)*
Average Gasoline Vehicle (Car)	0.2131
Average Diesel Vehicle (Van/Microbus/Light Duty Truck)	0.2933
Diesel Bus (Coach)	0.9116

*(EPA, 2020a)

In AY 18, the emissions factors for the Average Gasoline Vehicles and Average Diesel Vehicles decreased from factors used in previous Carbon Footprint Reports, while the Emissions Factor for Diesel Buses increased. The research team speculates that the increases and decreases in emissions factors is due to updated emission modeling and the general increase in fuel efficiency due to newer vehicles on the market.

4.3. Air Travel

4.3.1. Emissions

In AY 19, business air travel by faculty and staff totaled 11,788,385 passenger kilometers and emitted an estimated **1,217 MT CO₂e**. In AY 20, business air travel by faculty and staff totaled 9,183,222 passenger kilometers and emitted an estimated **965 MT CO₂e**. From AY 19 to AY 20, passenger kilometers fell 22% and emissions fell 21%. Long haul air travel in AY 20 accounted for 73% (**704 MT CO₂e**) of the total greenhouse gas (GHG) emissions in AY 20 (see **Figures 9** and **10**). The continuous decrease in air miles logged for business trips can be attributed to a combination of more stringent approvals for business trips, budget constraints, and a switch to attending more local conferences in lieu of international ones. In AY 20, and due to COVID-19 pandemic, all business trips have been cancelled during the period of (March 15, 2020 –August 31, 2020).

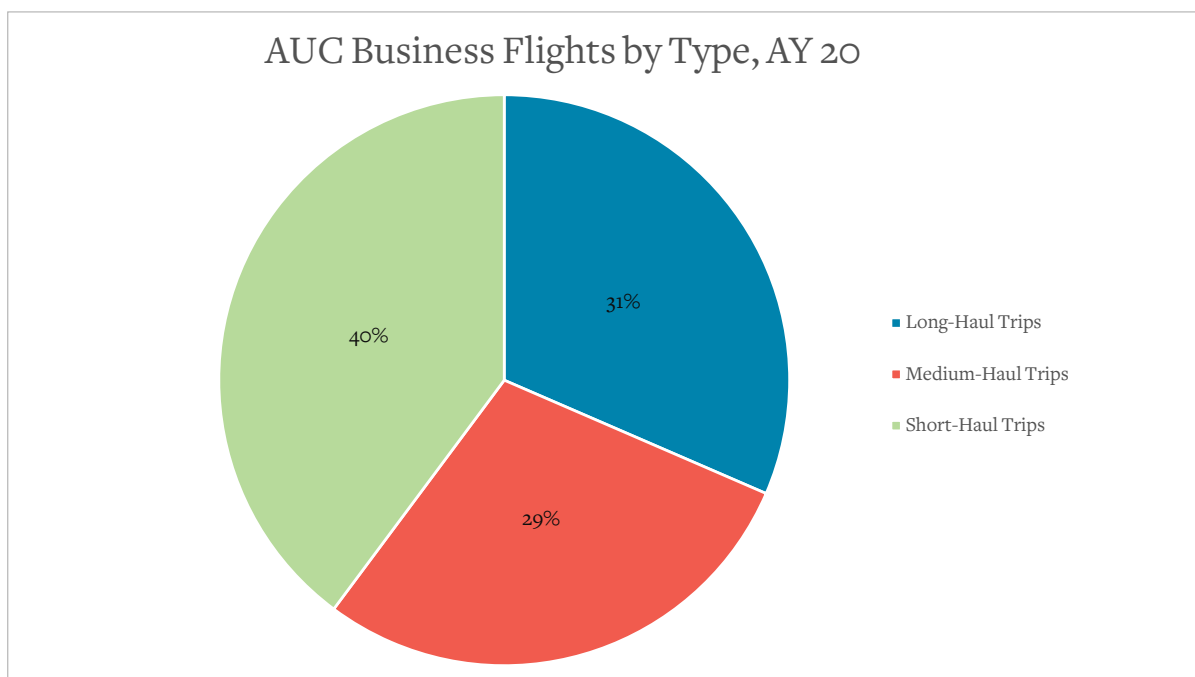


Figure 9. Short-, Medium- and Long-Haul, business-related flights taken by the AUC Community.

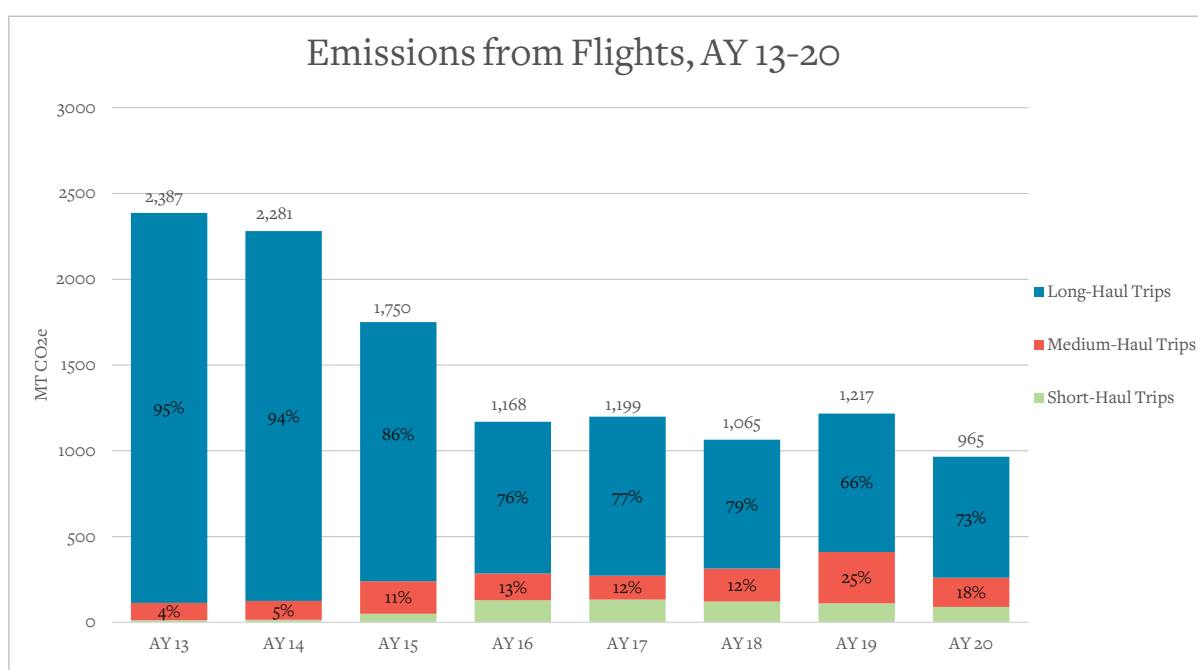


Figure 10. Emissions resulting from business air travel.

4.3.2. Methodology

The AUC's Office of Travel and Business Support coordinates business travel. All business flights booked through the Office are compiled in a database. Only business (non-personal) flights were examined. Flight distances were obtained preliminarily from third-party travel agents, then verified against great circle routes. After determining the km traveled, each flight was classified for Emissions Factor purposes by its length (Short-, Medium- or Long-Haul) and its booking class (first, business or economy). Then, flights were subdivided into Short- Haul (≤ 785 km), Medium-Haul (between 785 km and 3,700 km) and Long-Haul ($\geq 3,700$ km). The total km for each flight category was then multiplied by the pertinent Emissions Factor.

4.3.3. Data Sources

Data on air travel provided by AUC's Office of Travel and Business Support.

4.3.4. Emissions Factors

Source	Mass Emissions (kgCO ₂ e/passenger km)*		
	Short Haul	Medium Haul	Long Haul
First Class	0.1292	--	0.30908
Business Class	0.1292	0.12132	0.22408
Economy Class	0.1292	0.08088	0.07727

*(DEFRA/DECC 2020)

4.4. University Fleet

4.4.1. Emissions

The University operates a fleet of 93 vehicles, comprised of 60 gasoline cars and 33 diesel light-duty vehicles, for transportation of University personnel and other daily operations. In AY 20, emissions were **214 MT CO₂e** from the gasoline vehicle fleet and were **119 MT CO₂e** from the diesel fleet (see **Figure 11**). The total emissions from the University vehicle fleet in AY 20 were **332 MT CO₂e**. From AY 18 to AY 20, total fleet size increased by 9%, but total emissions decreased by 35% due to a decrease in km travelled by both gasoline and diesel vehicles.

From AY 18 to AY 19, the fleet size increased by 4% and total emissions increased by 18%. In AY 20, the fleet size was reduced, along with the distances traveled by the vehicles.

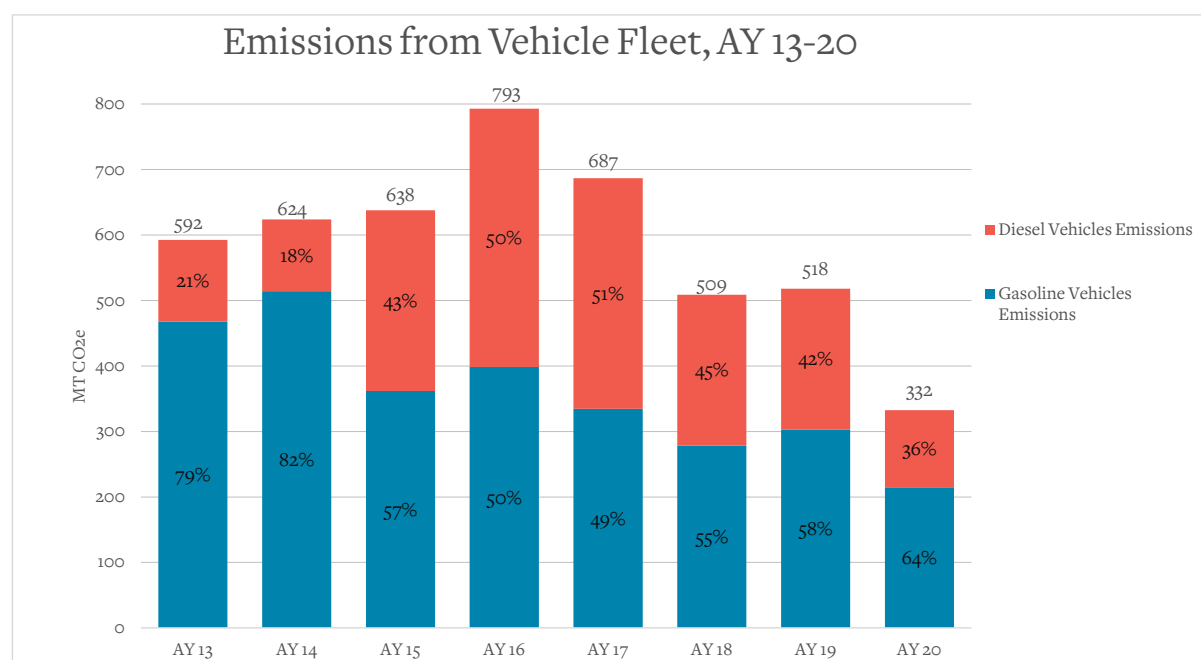


Figure 11. Emissions from the vehicle fleet.

4.4.2. Methodology

Emissions factors were based on the types of vehicles and the liters of fuel consumed. For the gasoline vehicle fleet, an average EF for gasoline cars was used. For the diesel fleet, made up almost entirely of minibuses, an average EF for diesel light duty trucks (vans) was used. Total amounts of fuel used were multiplied by their respective EF.

4.4.3. Data Sources

We obtained data on the University fleet from AUC's Office of Transportation Services.

4.4.4. Emissions Factors

Source	Mass Emissions (kgCO ₂ e/L of fuel used)*
Average Gasoline Vehicle (Car)	2.3194
Average Diesel Vehicle (Van/Microbus/Light Duty Truck)	2.6972

*(EPA, 2020a)

4.5. Sponsored Field Trips (Without Air Travel)

4.5.1. Emissions

AUC supports academic departments and student organizations in their efforts to take learning outside of the classroom and into the surrounding area. University-sponsored field trips have more than doubled since AY 16. In AY 20, field trips resulted in an estimated 36,771 km travelled by bus. Total emissions were approximately **22 MT CO₂e**. Safety in Egypt has increased in the past few years, allowing for more field trips. From AY 18 to AY 20, the number of trips decreased by 36%. Due to the COVID-19 pandemic, the University halted all sponsored field trips after March, 2020.

4.5.2. Methodology

Distances to destinations were estimated using Google Maps with the departure point assumed to be AUC's New Cairo Campus. When the final destination was a city, distance was measured to the city center. It was assumed that travel was by full-size bus using diesel fuel, since this is the most commonly used method of transportation for field trips.

4.5.3. Data Sources

We obtained data on the field trips from the AUC's Office of Security.

4.5.4. Emissions Factors

Source	Mass Emissions (kgCO ₂ e/km traveled)*
Diesel Bus (Coach)	0.86184
Microbus	0.28645
Coaster	0.28645

*(EPA, 2020a)

Recommendations to reduce your transportation footprint:

- Utilize the AUC bus system instead of commuting by private car. If a bus route doesn't stop directly at your destination, consider walking or taking public transit after the bus.
- If commuting by private car, make sure to have at least one other passenger with you. Carpooling helps take private cars off the road and decreases your carbon footprint. AUC also gives free parking to those who carpool.
- If you live in New Cairo, consider walking or biking to campus. These activities use your own energy and do not add to your carbon footprint.

For an updated transportation schedule, please visit: www.aucegypt.edu/campus-life/services/bus

Chapter 5

Electricity for Lighting and Other Equipment (Non-HVAC)

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
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9 INDUSTRY, INNOVATION
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11 SUSTAINABLE CITIES
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12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



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BELOW WATER



15 LIFE
ON LAND



16 PEACE, JUSTICE
AND STRONG
INSTITUTIONS



17 PARTNERSHIPS
FOR THE GOALS



5.1 Summary

As discussed in **Chapter 3** and **Appendix 2**, in AY 20, it is estimated that electricity used on campus for HVAC and non-HVAC (lighting and other equipment), was 55% and 45% respectively. This conclusion was based on test shutdowns conducted by the Office of Facilities and Operations. By shutting down all major HVAC equipment during working hours, we found that campus-wide electricity demand was reduced by approximately 45%. This number represents AUC's non-HVAC electricity usage, the remaining electricity used on campus primarily for lighting, office equipment and lab equipment. The non-HVAC electricity usage for lighting and other electrical equipment accounted for 21% of AUC's total carbon emissions in AY 20 (see **Figure 1**).

5.2 Emissions

In AY 20, AUC emitted **15,637 MT CO₂e** from electricity use, of which **7,037 MT CO₂e** resulted from the non-HVAC use of lighting and other electrical equipment (see **Figure 12**). AUC decreased emissions from non-HVAC by 13% from AY 12-20. The decrease can be explained by energy reduction strategies implemented by the Office of Facilities and Operations, as well as the efforts of the Energy and Resource Conservation and Efficiency (ERCE) Task Force. For insight into the methodology, assumptions, and data sources that led to this figure, see **Section 3.2**.

From AY 18 to AY 19, emissions from non-HVAC increased by 11%. This increase can be attributed to an expansion of campus operations and campus-wide events. From AY 19 to AY 20, emissions from non-HVAC decreased by 23%. This is a result of the COVID-19 pandemic that greatly reduced campus operations and limited lighting to only essential locations.

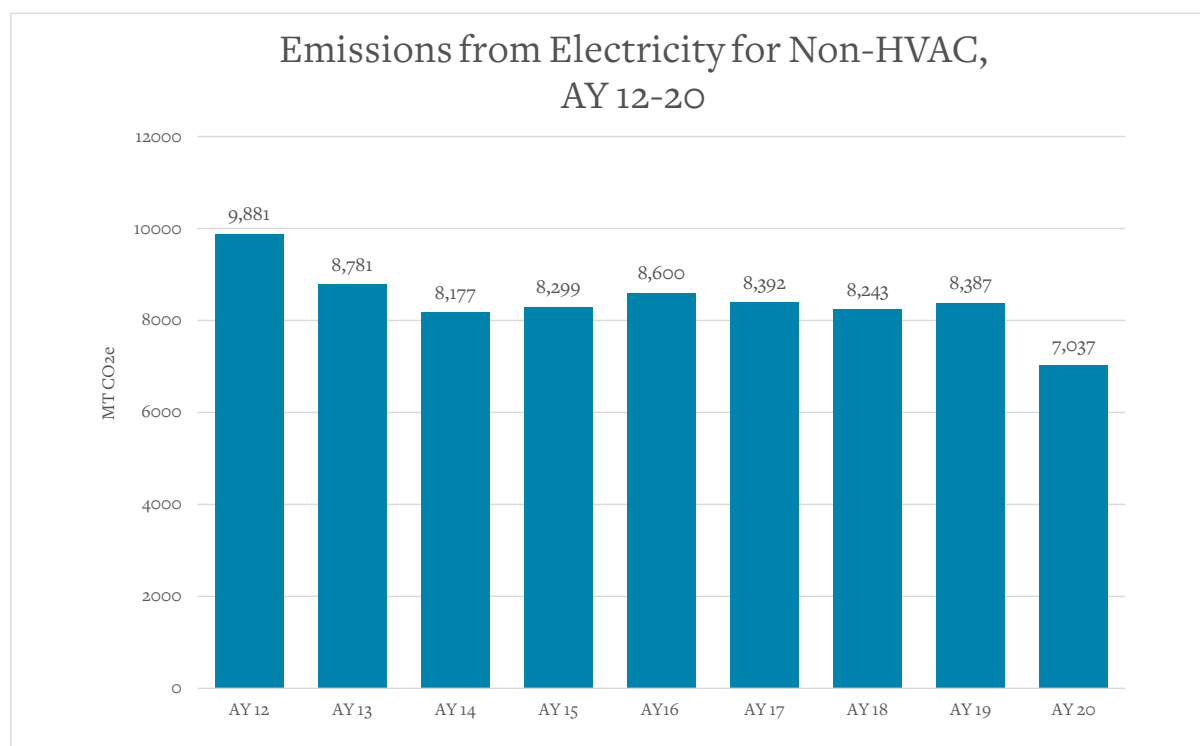


Figure 12. Non-HVAC electricity emissions.

Recommendations to reduce your electricity footprint:

- Turn off the lights when leaving a room. This includes classroom lights.
- Unplug unused electronics (chargers, gaming systems, hair dryers). Plugged-in, unused electronics still use electricity in the form of “vampire energy.”
- Power down on-campus computers and projectors when you are the last person to use them.

If there are problems with motion sensors in University residences and buildings, please contact Maintenance Services Center (Facilities & Operations) at [Ext. 2222](#).

Do your part to keep AUC from wasting unneeded electricity.

Chapter 6

Refrigerants

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
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6.1. Emissions

The University uses three types of refrigerants for refrigerators and stand-alone air conditioning units: R22 (HCFC-22), R407c, and R134 (HFC-134a). R134 was reported in AY 17, AY 18, and AY 19 but it was not significant in other reporting years. For AY 20, 121 kg of R22 and 34 kg of R407c were utilized, amounting to 155 kg. Total emissions from refrigerants were **279 MT CO₂e** in AY 20, which was a 51% overall decrease from AY 12-20 (see **Figure 13**).

From AY 18 to AY 19, emissions from refrigerants increased 40% as a result of increased maintenance activities needed for the older air conditioning units. This maintenance included the use of a refrigerant to charge the refrigeration circuits, explaining the increase in the R22 emissions from 195 MT CO₂e in AY 18 to 415 MT CO₂e in AY 19. In AY 20, twenty of the older air conditioning units were replaced with new units. This upgrade improved the performance of the systems, resulting in a large decrease of R22 emissions in AY 20. Currently, there are approximately 450 independent air conditioning units throughout campus, with most using R22.

In AY 19, refrigerator and water dispenser units were installed in the students and faculty housing, resulting in the consumption of R134. In AY 20, no R134 was consumed because of the increased preventive maintenance done in AY 19 and because of the closure of the campus due to the COVID-19 pandemic. In AY 20, there was an upgrading project in the data center to add three new units, increasing performance and resulting in a substantial decrease in R407c usage.

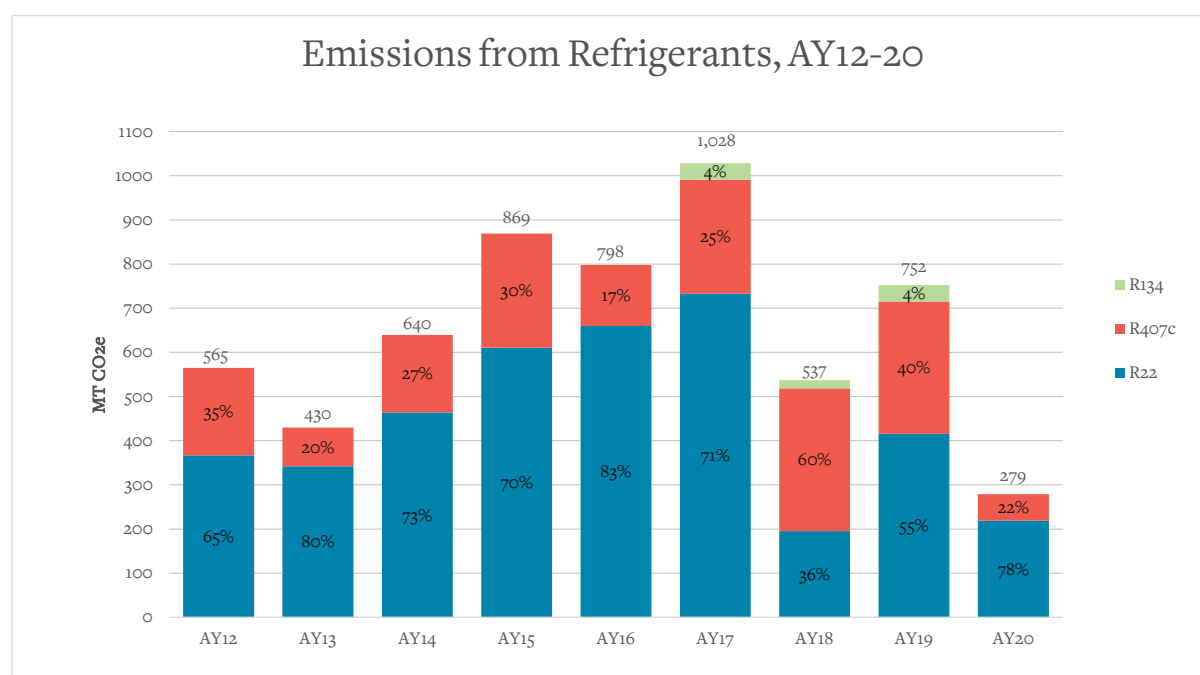


Figure 13. Emissions from refrigerants R134, R22 and R407c.

6.2. Methodology

The amounts of refrigerants lost to leakage or unintended releases were calculated by determining the amounts of refrigerants re-added to the air conditioning units. These re-added refrigerants were then multiplied by the respective Emissions Factor (EF). In AY 18, 19, and 20, the EF for R407c was 1774 kgCO₂e/kg, while from AY 12-17, the EF was 1526 kgCO₂e/kg.

6.3. Data Sources

We obtained information on refrigerants from AUC's Office of Facilities and Operations.

6.4. Emissions Factors

Source	Mass Emissions (kgCO ₂ e/kg)*
R22	1,810
R407c	1,774
R134	1,430

*(DEFRA/DECC 2020)

Chapter

Paper Supply

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
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7.1. Emissions

In AY 20, the University purchased an estimated 147,483 kg of paper products, totaling **1,313 MT CO₂e**. (see **Figure 14**).

From AY 12 to AY 20, there was a 40% decrease in the amount of paper tonnage used by AUC. In the years following AUC's move to the New Cairo Campus, paper consumption declined steadily from AY 12 to AY 15. This decline can be attributed to a variety of changes, including the standardization of centralized printing stations, campaigning for double-sided printing, and digitizing standard University paperwork processes. AUC now relies solely on the electronic versions of University policies, technical manuals, employee directories, and job postings. The increase in paper use from AY 15 to AY 16 is positively correlated with the increases of campus operations and energy consumption in the same period.

The decrease in paper use from AY 16 to AY 19 can be attributed to a new paper recycling campaign and the administration's recent push to go paperless. The paper recycling campaign was implemented in Fall 2017, and it consisted of removing paper bins from the campus waste sorting stations and adding smaller paper collection bins in offices and classroom buildings. The paper recycling campaign not only increased AUC's capture of paper for recycling, but made faculty, staff, and students more aware of their paper usage. On top of the paper recycling campaign, the administration has made a point to streamline its operations and move towards a paperless operating system.

The increase in paper use in AY 20 can be attributed to the marketing of AUC's yearlong Centennial celebrations. The university invested in a variety of different branded merchandise and promotional resources for the major campus event.

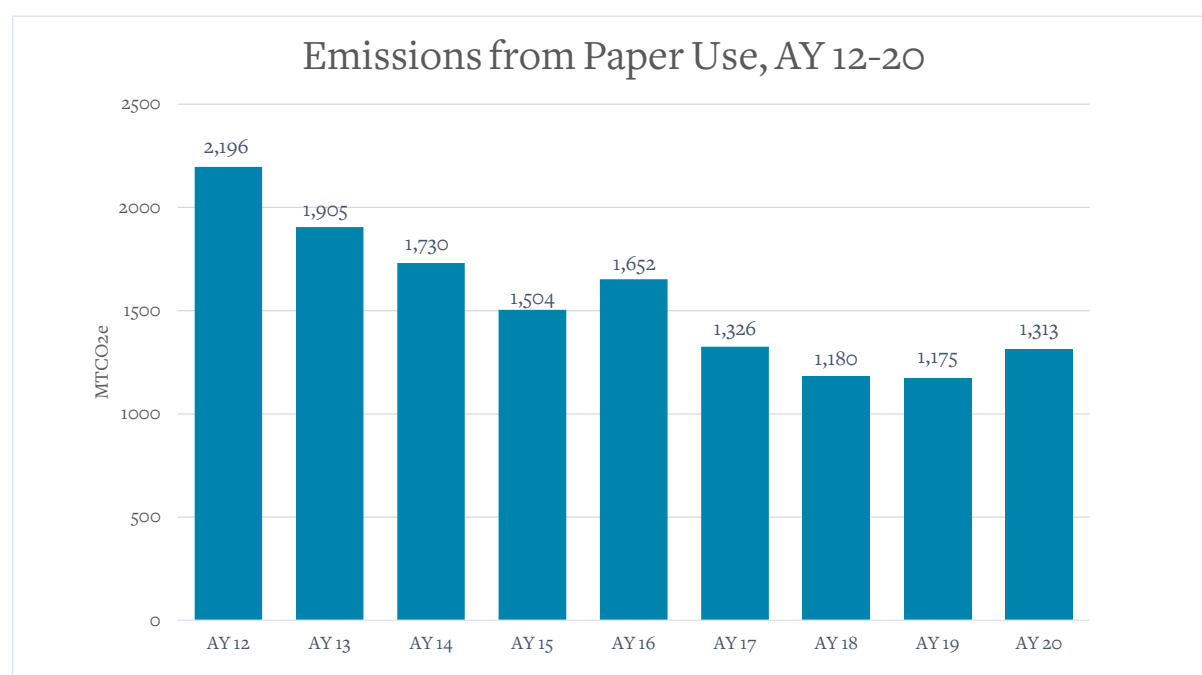


Figure 14. Emissions from paper use.

7.2. Methodology

The research team reviewed all paper purchase invoices and weighed samples of each type of paper. More than 99% of the paper AUC purchases is uncoated, hence we decided to use the uncoated paper emission factor for all paper. None of the paper used at AUC is recycled in origin.

7.3. Data Sources

We obtained information on paper purchases from AUC's Office of Procurement Services and Material Management, which maintains records of quantities and types of paper purchased.

7.4. Emissions Factor

Source	Mass Emissions (MT CO ₂ e/MT of paper)*
Uncoated Paper	8.9

Recommendations to reduce your paper footprint:

- Instead of printing, use email and electronic copies of documents. Printing uses paper, ink, and electricity.
- Set printer settings to double-sided, 12pt. font, and black and white.
- Remove personal printers and establish an office-wide printer to better track paper usage.

*(Environmental Paper Network, 2018)

Chapter 8

Water Supply

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
ECONOMIC GROWTH



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



10 REDUCED
INEQUALITIES



11 SUSTAINABLE CITIES
AND COMMUNITIES



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



14 LIFE
BELOW WATER



15 LIFE
ON LAND



16 PEACE, JUSTICE
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8.1 Summary

The two types of water that serve the New Cairo Campus are domestic and treated wastewater. Domestic water refers to drinkable water that comes to the campus through the municipality infrastructure system. Treated wastewater refers to the municipally treated wastewater that is further treated when delivered to the on-campus treatment plant. The treated wastewater is exclusively used for landscaping irrigation.

In AY 20, the University consumed a total of 602,572 m³ of water, with 44% of the total water consumption being domestic and 56% of the total water consumption being treated wastewater (see **Figure 15**). In AY 19, the University consumed a total of 630,613 m³ of water, with 49% of the total water consumption being domestic and 51% of the total water consumption being treated wastewater. In AY 18, the University consumed a total of 616,733 m³ of water, with 59% of the total water consumption being domestic and 41% of the total water consumption being treated wastewater. From AY 18 to AY 20, total water consumption decreased by 2%, from which water consumption from treated wastewater increased by 32% and water consumption from domestic water decreased by 27%. From AY 19 to AY 20 total water consumption decreased by 4%, from which water consumption from treated wastewater increased by 5% and water consumption from domestic water decreased by 14%.

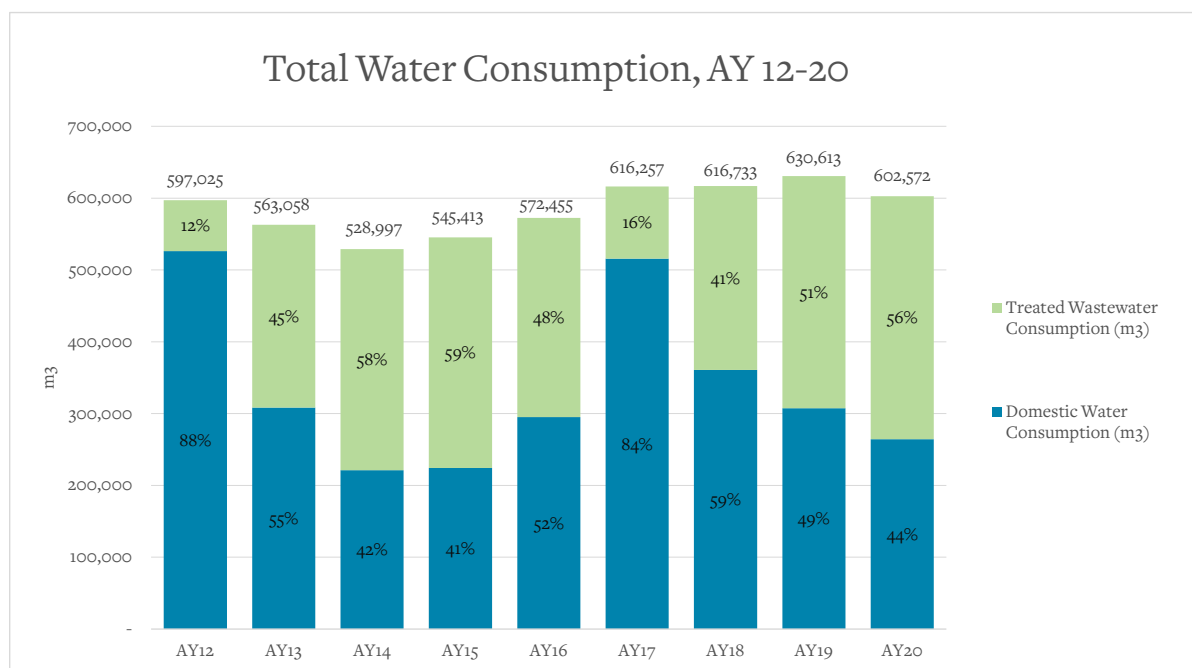


Figure 15. Total campus water consumption (m³).

8.1.1. The Energy-Water Nexus

The energy use and water supply at AUC are interconnected. The New Cairo Campus is located on an elevated desert plain east of central Cairo. As per a study conducted by Chemonics, in order to supply domestic water to AUC from the Ismailiya Canal northeast of Cairo, water must be purified and pumped across a distance of 54.45 kilometers up inclines totaling 308 meters (Stahl & Ramadan, 2008).

On-campus water consumption is divided into three categories: air conditioning cooling towers, landscaping irrigation, and building use. Reducing campus water consumption not only reduces overall energy consumption, but it also saves already scarce water resources. Intensified local demand for a limited supply of water resources further creates a need for more efficient water usage and innovative reuse of wastewater.

8.2. Emissions

8.2.1. Overview

In AY 20, the University consumed a total of 602,572 m³ of water. Of this, 72,542 m³ was used for the air conditioning cooling towers, 170,652 m³ for buildings, and 359,378 m³ for irrigation. The carbon emissions resulting from this consumption amount to **561 MT CO₂e**. Of this total, **88 MT CO₂e** (16%) can be attributed to the air conditioning cooling towers, **207 MT CO₂e** (37%) can be attributed to consumption for domestic use in buildings and other uses, and the remaining **266 MT CO₂e** (47%) can be attributed to irrigation (see **Figure 16**).

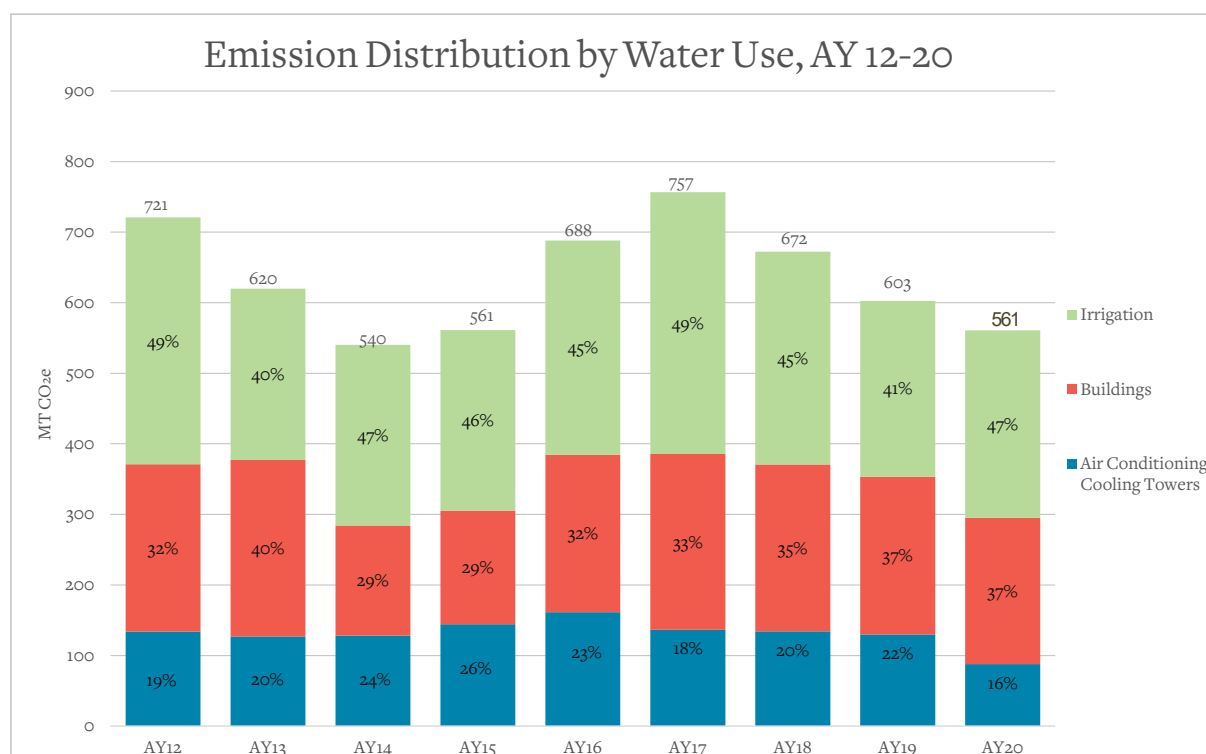


Figure 16. Emissions distribution for water by water use.

Total water emissions were **721 MT CO₂e** in the Base Year AY 12 and **561 MT CO₂e** in AY 20, showing an estimated 22% decrease in emissions from AY 12-20. Water consumption during the same period increased by 1%. Though the total water consumption of the University had increased, there was a decrease in emissions due to a higher substitution of treated wastewater for domestic water for landscape irrigation (see **Appendices 5** and **6**). Less energy is needed to bring treated wastewater to the New Cairo Campus than is needed to bring the equivalent amount of domestic water.

The University's decision in AY 12 to use treated wastewater for landscape irrigation has resulted in savings of **1,237 MT CO₂e** in cumulative emissions from AY 12 to AY 20 compared to if we had continued to solely use domestic water for irrigation (see **Section 8.3**).

Focusing on the most recent data, AUC's water consumption increased from AY 18 to AY 19 by 2% due to the following reasons:

- Increase of monthly and yearly average temperature, which increases the need for air conditioning, the evaporation rate of water used for irrigation, and the need for domestic drinking water.
- Higher occurrence of campus events, which increases the need for cleaning.

Despite this increase in consumption, emissions decreased by 10% from AY 18 to AY 19 due to a higher

proportion of treated wastewater used (see **Figure 17**). In AY 18, domestic water emissions accounted for 71% of AUC's total water emissions, while 29% came from treated wastewater emissions. In AY 19, the domestic water emissions accounted for approximately 62% of AUC's total water emissions, while 38% came from treated wastewater emissions.

From AY 19 to AY 20 AUC's water consumption decreased by 4% and emissions decreased by 7%. The COVID-19 pandemic decreased the campus population, which reduced the need for air conditioning and building water use. In addition, emissions reduced in AY 20 due to the increased use of treated wastewater and reduced campus operations (see **Figure 17**). In AY 20, domestic water emissions accounted for approximately 57% of AUC's total water emissions, while 43% came from treated wastewater emissions.

From AY 18 to AY 20, treated wastewater emissions increased by 22%. **Figure 17** describes the breakdown in the emissions resulting from both treated wastewater and domestic water. Emissions resulting from domestic water consumption decreased by approximately 32% from AY 18-20.

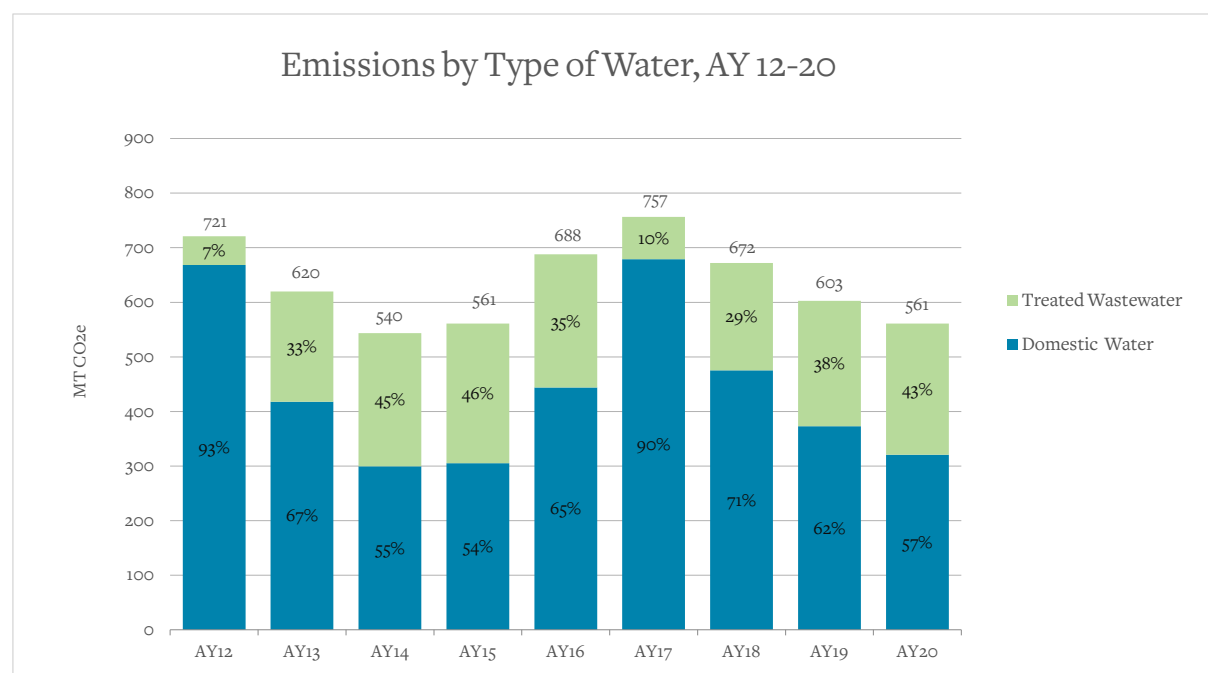


Figure 17. Emissions from supplying domestic water and treated wastewater.

8.2.2. Water for Air Conditioning Cooling Towers

The gas-driven chillers that produce chilled water for air conditioning generate heat that is partially wasted when it dissipates in the atmosphere. The waste heat is dissipated through a circulating water system that releases it from the five cooling towers through evaporation.

The consumption of domestic water by cooling towers for air conditioning increases considerably during the hot summer months (May through October), contributing to 15-26% of the University's total monthly water use (see **Figure 18**). In the summer months of AY 20, consumption of domestic water for air conditioning was significantly lower than in previous years. The COVID-19 pandemic and the subsequent shift to online teaching and remote working reduced AUC's summer programming and thus the need for cooling the campus. We calculated carbon emissions resulting from the use of domestic water for the air conditioning cooling towers by multiplying the volume of water consumed by the electricity required to bring each cubic meter of water to the New Cairo Campus (see **Section 8.3**), then applying the Emissions Factor (EF) (see **Section 8.5**) for electricity obtained from the EEA.

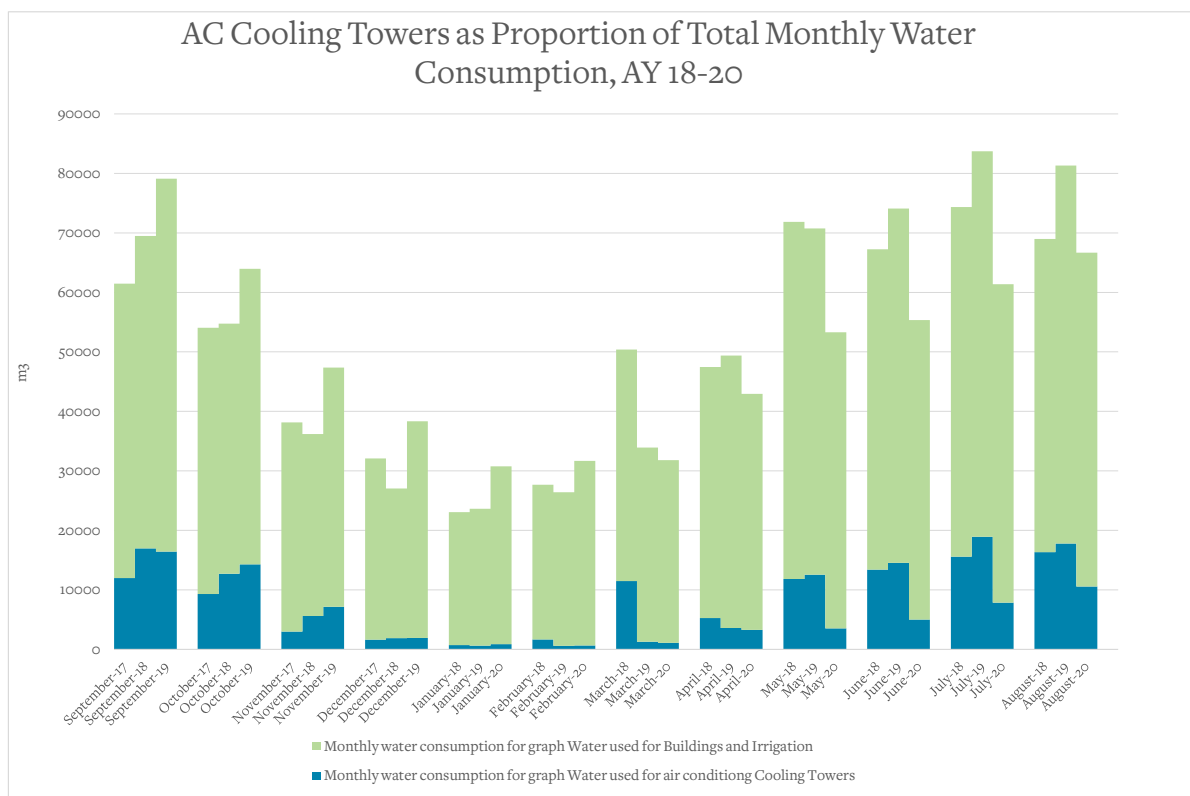


Figure 18. Proportion of water used for air conditioning cooling towers of total monthly water consumption.

8.3. Methodology for Calculating Carbon Emissions Attributable to Domestic Water Supply and Treated Wastewater Supply

AUC has continued to improve management of its water supply since AY 12. Notable water efficiency initiatives include smart flushing technology across campus, low-flow showerheads, and more water-efficient plants in campus landscaping. The most significant factor is the use of treated wastewater for irrigation. Recycling water in this manner not only helps alleviate regional water scarcity but results in energy savings and fewer carbon emissions as well. This is due principally to a lower energy pumping factor for each cubic meter of treated wastewater compared to domestic water.

Chemonics Egypt has contributed to AUC's carbon footprint reports by mapping the domestic water supply route from the original source and analyzing energy consumption to AUC. Chemonics concluded that 2.55 kWh of electricity are required to bring each cubic meter of domestic water from the Ismailiya Canal to the New Cairo Campus (see **Appendix 4**). After AUC switched to using treated wastewater for irrigation, Chemonics did a second study on the New Cairo municipal wastewater treatment system and determined that the energy needed to deliver treated wastewater to the New Cairo Campus is only 1.49 kWh/m³ (see **Appendix 5**), a savings in energy consumption from that of domestic water of more than 40%.¹

The University has also improved its own water consumption data collection and management practices from the Base Year AY 12 to AY 20. Yearly recalibration of the meters and the gradual switch to digital meters allows us to produce increasingly detailed monthly records of both domestic and treated wastewater consumption.

8.4. Data Sources

The total consumption of water by the University is based on water meter readings for all water

¹ The Chemonics Egypt studies of energy consumption for domestic and treated wastewater supply were conducted in 2011 and 2012.

used on campus. This includes water used for domestic consumption in air conditioning cooling towers, buildings, and irrigation, as well as treated wastewater for irrigation. We obtained energy consumption factors for water delivery to the New Cairo Campus from Chemonics Egypt and data on University water consumption from AUC's Office of Facilities and Operations.

8.5. Emissions Factor

Source	Mass Emissions (kg CO ₂ e/kWh)*
Cairo Electrical Grid	0.4760

*(EEA, 2019)

Recommendations to reduce your water footprint:

- Shorten your shower to 3-5 minutes. An average shower uses 5 gallons of water per minute. If you shorten your shower by 2 minutes, you can cut water use by 10 gallons. Try making a short shower music playlist or set a timer to ensure you get out on time.
- Wash your clothes in cold water instead of warm. Cold water uses less energy and helps reduce clothing shrinkage.

If you see a water leakage on campus, whether inside in a shower, sink or toilet, or outside in garden or irrigation areas, please report it by calling Maintenance Services Center (Facilities & Operations) at [Ext. 2222](tel:2222).

Chapter 9

Solid Waste Disposal

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
ECONOMIC GROWTH



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



10 REDUCED
INEQUALITIES



11 SUSTAINABLE CITIES
AND COMMUNITIES



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



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BELOW WATER



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ON LAND



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AND STRONG
INSTITUTIONS



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FOR THE GOALS



9.1. Emissions

We estimate that the University produced 358 MT of solid waste in AY 20. The University produced 514 MT of solid waste in AY 19, and 409 MT of solid waste in AY 18. From AY 18-20, there was a 12% decrease in the amount of solid waste produced.

If placed in a landfill, the AY 20 tonnage would have generated 14 MT of Methane (CH_4). Due to Methane having a higher Global Warming Potential (GWP) than CO_2 , the 14 MT of Methane would have emitted an estimated **302 MT CO_2e** . However, the solid waste produced on campus is collected daily by the *Zabaleen*, the trash-collecting community in Cairo. Based on a review of the recent literature on recycling by the *Zabaleen*, we estimate that at least 80% of all solid waste collected by the *Zabaleen* is recycled (EJA, 2017; Zafar, 2018). Accordingly, AUC emitted **60 MT CO_2e** from solid waste disposal in AY 20, representing the 20% of solid waste produced by the University that was ultimately landfilled and not recycled.

Solid waste that was landfilled emitted approximately **69 MT CO_2e** in AY 18 and approximately **87 MT CO_2e** in AY 19. From AY 12 to AY 20, solid waste emissions have decreased by 42%. (see **Figure 19**).

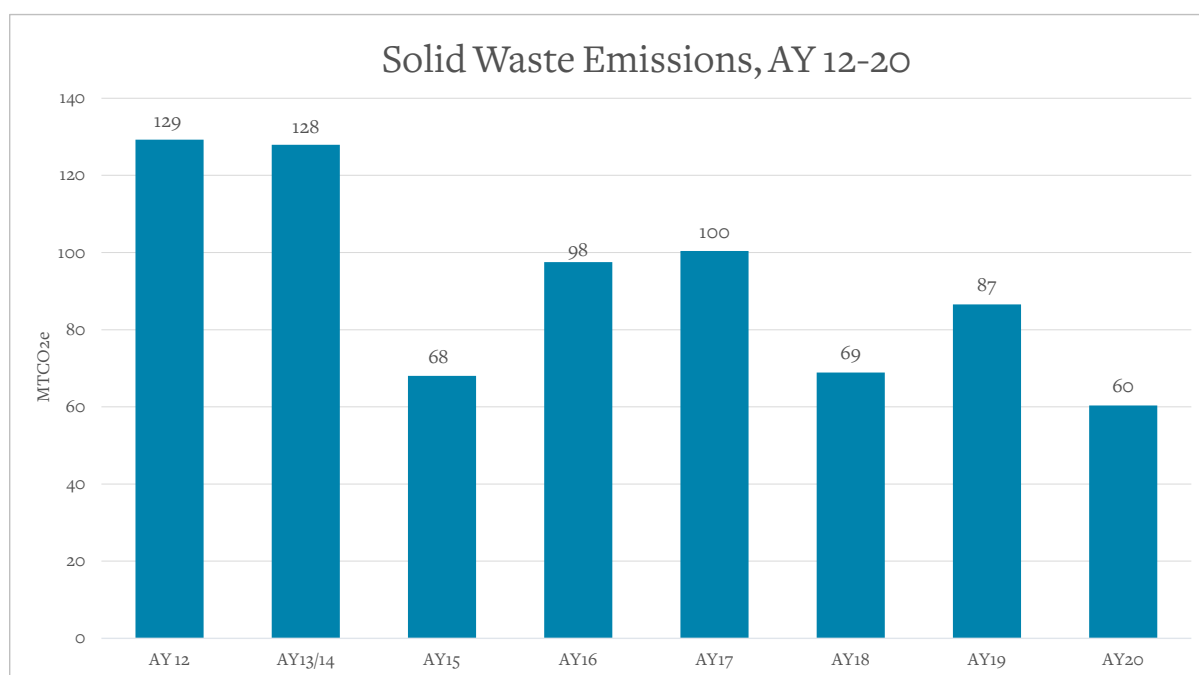


Figure 19. Emissions from solid waste.

9.2. Methodology

In order to estimate the tonnage of solid waste produced in AY 19, two one-week sampling assessments were conducted. Waste leaving campus was weighed every day for one week during a non-peak time (summer semester) and a peak time (fall semester). Solid waste tonnages were measured by weighing the trash trucks when loaded and when empty, then calculating the differences in weights.

Throughout the year, and even throughout the week, there are days of low population density on campus (less than half the student body and fluctuating amounts of staff and faculty) and days of high population density (most students, staff, and faculty are present). Based on the University's academic calendars and online transportation surveys, we estimate that the New Cairo Campus is densely populated 30% of the time and lightly populated 70% of the time. This fluctuation causes variation in the amount of solid waste produced per day. To account for this difference, a yearly average was calculated.

To estimate the tonnage of solid waste produced in AY 20, the impact of COVID-19 had to be accounted for. Waste leaving campus was weighed every day for one week during the fall semester, prior to COVID-19, and one week during the remote working and online teaching period on campus. Based on the University's calendar and the timing of COVID-19, we estimate that the New Cairo Campus was densely populated 25% of AY 20 and lightly populated 75% of AY 20. The COVID-19 pandemic reduced the number of densely populated days as well as decreased the population density on the lightly populated days compared to previous years. Both of these factors, less high populated days, and a lower population density on low population days, decreased in the amount of solid waste produced in AY 20.

9.3. Data Sources

Data on the amounts of solid waste produced was provided by AUC's Office of Facilities and Operations.

9.4. Emissions Factor

Source	Mass Emissions (kgCO ₂ e/MT)*
Municipal Solid Waste	842.1

*(IPCC, 2006)

Recommendations to reduce your solid waste footprint:

- Purchase a reusable water bottle. At the time of writing, there are 39 chilled water dispensers on the New Cairo Campus and 2 on the Downtown Tahrir Campus. A reusable water bottle will help decrease the amount of single-use plastic bottles.
- Purchase a reusable bag. Plastic bags easily break down and are often unrecyclable. Carrying a reusable bag is a helpful way to cut down on waste.
- Reduce your personal food waste by saving leftovers rather than discarding them. Choose foods and other products that have minimal packaging.

If you have questions or concerns regarding the waste sorting stations located on campus, please email sustainability@aucegypt.edu.

Chapter 10

Natural Gas

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
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AND PRODUCTION



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ON LAND



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FOR THE GOALS



10.1. Emissions

In AY 20, the total natural gas consumption for the New Cairo Campus for domestic and lab use was 1,046,534 m³, a decrease of 32% from 1,543,595 m³ in AY 19. The University emitted **2,326 MT CO₂e** from natural gas combustion in AY 20 (see **Figure 20**). This large decrease between AY 19 and AY 20 can be attributed to the COVID-19 pandemic, which reduced campus operations and natural gas consumption from the science labs and all food outlets for six months in AY 20. Since AY 15, the University has seen an 19% increase in natural gas emissions. The University has since implemented a pilot program designated for providing more accurate readings and for ensuring that natural gas emissions data can be better reported in subsequent carbon footprint reports.

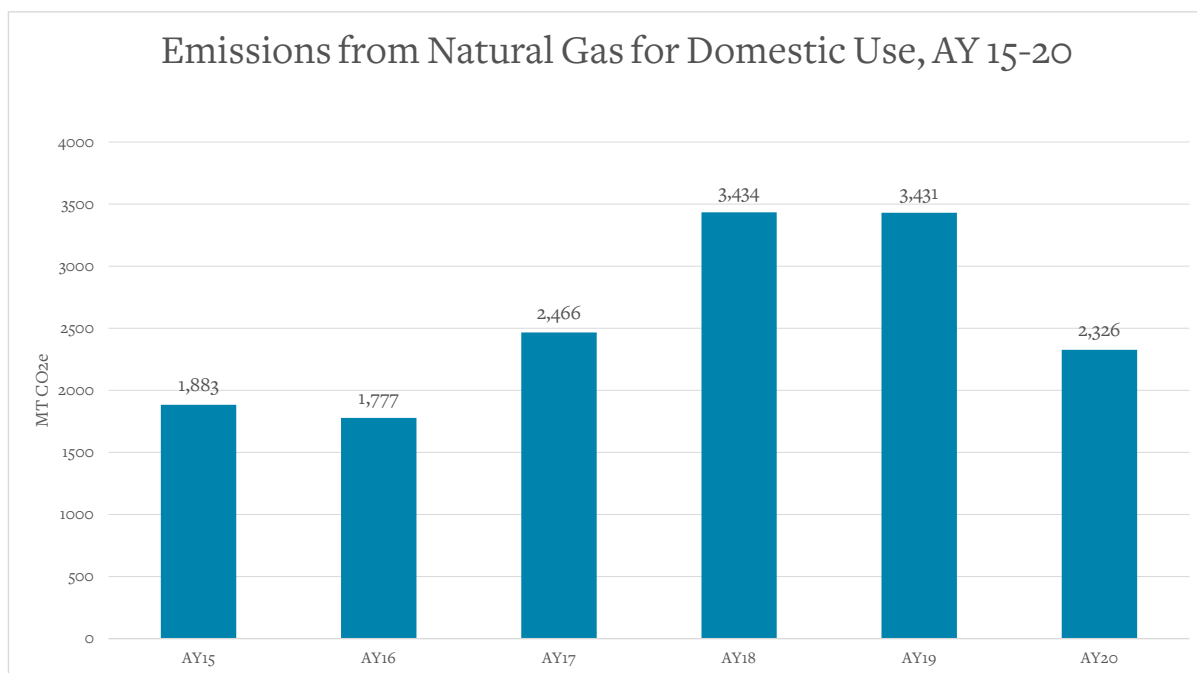


Figure 20. Emissions from natural gas for domestic use.

In the Carbon Footprint Report 2015, natural gas consumption for AY 12, AY 13, and AY 14 was omitted due to a publishing error. The report team realized that estimates for campus natural gas consumption were overly conservative and did not reflect the true value of University emissions. See **Section 10.2** below for an explanation of how the present figures are determined.

Natural gas serves several purposes on the New Cairo Campus, most notably for equipment within science labs and engineering departments such as chemistry, physics, and biology. Since the Carbon Footprint Report 2017, science labs have seen expansions in operational hours and in the number of operating facilities. Natural gas is also used for the operation of the main kitchens, food outlets, and newly installed décor studio.

10.2. Methodology

Natural gas is primarily used to power five main areas on the New Cairo Campus: food outlets (Campus Center), laundry rooms (Sports Complex), the main kitchen (Physical Plant), Visual Arts studio (Prince Alwaleed Bin Talal Bin Abdulaziz Bin Alsaud Building), and science labs (School of Science and Engineering). Currently, we have four meters for all of the areas except the science labs. In AY 20, Campus Facilities and Operations installed a main domestic meter in order to read the total natural gas consumption of AUC buildings. This project solved the previous meter issue and we now have more accurate and reliable readings. In AY 19, there was a problem with the building meters, leading to inaccurate measurements of natural gas consumption. The AY 19 estimate shown in **figure**

20 is a result of averaging AY 15 to AY 19 natural gas consumption measurements.

Previously, from AY 15 to AY 18, we assumed the gas consumption of the School of Science and Engineering labs. Recent review of the data has led us to conclude that earlier estimates were too conservative, thus the gas consumption figures reported in the previous Carbon Footprint Reports were too low. The total natural gas figure reported in this chapter is a product of calculating the difference between total gas consumption on campus (as reported by the main natural gas meter) and the consumption by the Central Utility Plant (CUP). The difference represents the combined natural gas usage across the five described areas.

10.3. Data Sources

We obtained consumption data on natural gas consumption from AUC's Office of Facilities and Operations.

10.4 Emissions Factor

Source	Mass Emissions (kgCO ₂ e/m ³)*
Natural Gas	2.023

*(DEFRA/DECC, 2020)

Chapter 11

Fertilizers

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
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9 INDUSTRY, INNOVATION
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AND STRONG
INSTITUTIONS



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FOR THE GOALS



11.1 Summary

For its campus landscaping needs, AUC uses a mix of organic fertilizer comprised of compost produced by the University on campus from landscape waste and of some purchased, as well as purchased synthetic fertilizer. Synthetic fertilizer is responsible for higher carbon emissions because of its higher nitrogen content than traditional compost. Compost has three advantages: (1) lower carbon emissions when used as fertilizer, (2) sequestration of carbon emissions that would have resulted from landscape waste if the organic waste decayed naturally (see **Chapter 12**), and (3) improvement of soil quality by increasing water retention, thus reducing the need for irrigation water, and reducing the carbon emissions associated with supplying irrigation water (see **Chapter 8**).

11.2. Emissions

In AY 20, AUC used 6.5 MT of solid synthetic fertilizers and 1,300 L of liquid synthetic fertilizers with nitrogen contents ranging from 7% to 46%. AUC also used 100 MT of organic fertilizer (produced or purchased compost) with a nitrogen content of 0.70%. Emissions from solid and liquid synthetic fertilizers totaled 7 MT CO₂e and emissions from organic fertilizer totaled 2 MT CO₂e. In total, 9 MT CO₂e were emitted as a result of fertilizer application on the New Cairo Campus (see **Figure 21**). There has been a 30% decrease in fertilizer emissions overall from the Base Year AY 12 to AY 20 due to an increased use of organic fertilizer and a decreased use of synthetic fertilizer. As shown in the figure below, the split between organic and synthetic fertilizer has changed. In AY 19, there was a 21% increase in emissions from synthetic fertilizer due to a higher consumption by the Landscaping Unit. In AY 20, the Landscaping Unit managed to use more organic fertilizer, therefore lowering overall emissions by 8% from AY 18.

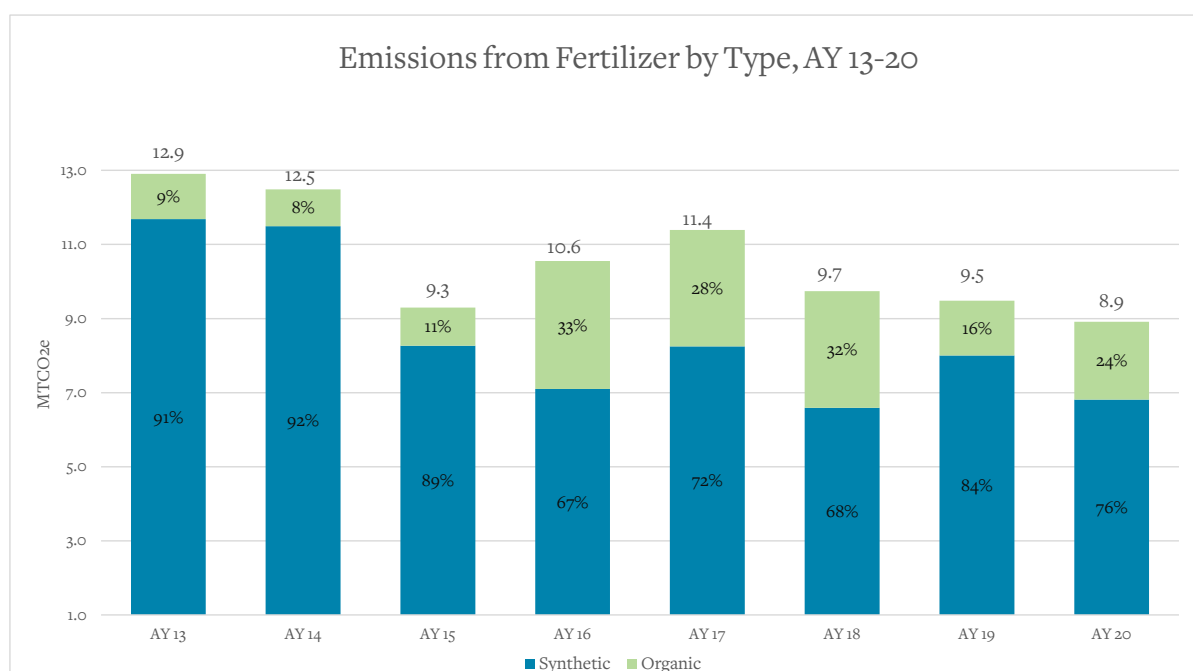


Figure 21. Emissions from the application of synthetic and organic fertilizers.

11.3. Methodology

The amounts of synthetic fertilizer and organic fertilizer (compost) used were multiplied by their respective percentages of Nitrogen to obtain the amounts of Nitrogen applied. In the cases of nitric and humic acid liquid fertilizers, the Nitrogen density of the solution was multiplied by the volume applied. The amounts of Nitrogen applied were then multiplied by the conversion factor noted in **Section 11.6** in order to determine the amounts of Nitrous Oxide (N₂O) emitted. Finally, the amount of N₂O emissions from each source was multiplied by the Global Warming Potential (GWP) of Nitrous Oxide, to determine the CO₂e emissions. In 2019, the GWP for Nitrous Oxide changed from 310 to

298. To maintain consistent data, the new GWP was retroactively applied to AY 13 – AY 18.

11.4. Emissions Savings from Compost Use

Emissions from fertilizer use would have been approximately **64 MT CO₂e** greater in AY 20 if synthetic fertilizer were used in lieu of organic fertilizer. The University produced 130 MT of compost on campus to avoid emitting **60 MT CO₂e** from the use of synthetic fertilizer. The University purchased an additional 20 MT of compost to avoid emitting the remaining **4 MT CO₂e** from the use of synthetic fertilizer. “Displaced Synthetic Fertilizer” in **Section 11.6** refers to emissions avoided by using organic compost instead of synthetic fertilizers (FAO, 2006). Over the past three years, the landscape team has worked to maintain the amount of purchased compost, thus emissions saving from compost use from AY 18 to AY 20 has remained consistent.

11.5. Data Sources

Data on synthetic and organic fertilizer use was obtained from AUC’s Office of Facilities and Operations. The Nitrogen content of both the synthetic fertilizers and the purchased compost was taken from information provided on the packages. The Nitrogen content of organic fertilizer produced from landscaping waste on campus was determined by the Office of Facilities and Operations through laboratory testing.

11.6. Emission and Other Relevant Factors

Source	Conversion Factor
Synthetic/Organic Fertilizer	Default Value: 0.01 kg N ₂ O/kg N* Uncertainty range: 0.003 - 0.03
Displaced Synthetic Fertilizer	260**

*(IPCC, 2006), **(FAO, 2006)

Chapter 12

Landscaping and Composting as Carbon Offsets

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



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AND STRONG
INSTITUTIONS



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FOR THE GOALS



12.1. Summary

Carbon sequestration is the capture and removal of Carbon Dioxide from the atmosphere in a stable, long-term reservoir, and it is a direct offset of other carbon emissions. “Direct offset” means that sequestered carbon may be subtracted from the CO₂e total in calculating carbon footprints (“Glossary of Climate Change Acronyms and Terms,” 2014). In this report, a total of **163 MT CO₂e** has been subtracted from the CO₂e total in calculating AUC’s total carbon footprint for AY 20.

The landscaping features on campus store and sequester CO₂ from the atmosphere through photosynthesis and soil storage properties. The Landscaping Unit also works to avoid carbon emissions by composting landscaping waste such as pruned tree branches and grass cuttings. If a plant is allowed to decompose naturally (anaerobically), some of the carbon sequestered by the plant through photosynthesis will be released back into the atmosphere. This release can be avoided through the carbon capture technique of aerobic composting.¹

12.2. Emissions Sequestered from Landscaping

For AY 19 and AY 20, we estimate that the landscaping on the New Cairo Campus sequestered **99 CO₂e** from the atmosphere. Of this total, **77 MT CO₂e** were sequestered by campus trees and **22 MT CO₂e** were sequestered by groundcover including grass and shrubs (see **Figure 22**). From AY 12-20, carbon sequestration from landscaping increased by 30%. This increase can be attributed to the recent completion of the landscaping master plan, as well as an increased use of green fences and lawns. Expanses in the groundcover outside the inner fence have also increased the sequestration rates. From AY 17 to AY 20, the campus landscape has been maintained without many changes, thus resulting in a consistent trend of emission savings.

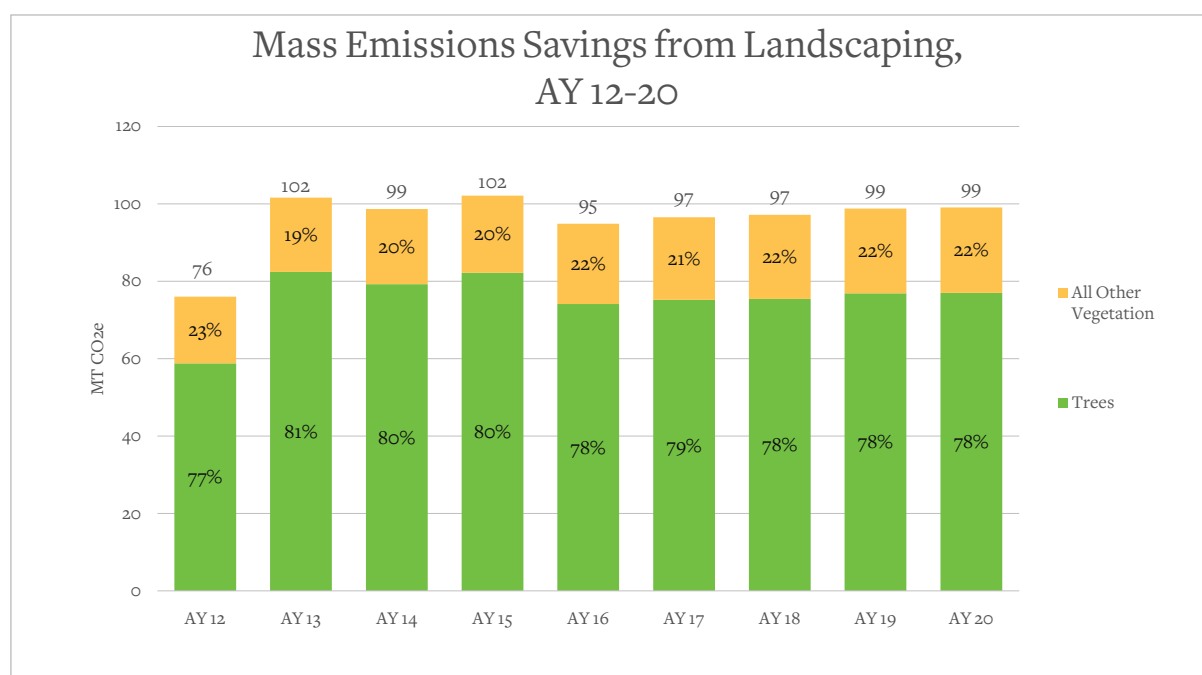


Figure 22. Emissions offsets from carbon sequestration by campus landscaping.

12.3. Methodology for Landscaping

The Landscape Unit of the Office of Facilities and Operations estimates that there are 7,672 trees planted on campus, of which 1,215 are date palms (*Phoenix dactylifera*). The remaining 6,457 trees are comprised of a variety of species, with Valencia orange trees (*Citrus sinensis*) making up the majority. Therefore, we assumed that all of the remaining 6,457 trees were Valencia orange trees. Additionally,

¹ When organic waste such as pruned tree branches and grass cuttings is left in place to decompose naturally, it decomposes anaerobically (without oxygen) and produces greenhouse gases. Creating compost from organic waste provides a way for the waste to decompose aerobically, as compost piles are turned and aerated, thereby sequestering carbon and reducing the greenhouse gases that otherwise would have been emitted. (IPCC, 2006).

there are approximately 18.85 acres of ground cover on the campus. To obtain the amount of carbon emissions sequestered, the tree quantities were multiplied by the corresponding emissions offset rates in **Section 12.8**. The amount of groundcover was also multiplied by the pertinent emissions offset rate in **Section 12.8** to result in the carbon emissions sequestered by landscaping groundcover.

12.4. Data Sources

The rate of carbon sequestration by date palms was obtained from the U.S. Forest Service Tree Carbon Calculator (USDA, 2013) and the rate of sequestration by orange trees was taken from a 2012 study on the sequestration potential of tree plantations (Kongsager et al., 2012). All data regarding landscaping and composting at AUC's New Cairo Campus was provided by the Landscape Unit of the Office of Facilities and Operations.

12.5. Carbon Sequestration through Composting

Aerobic composting captures carbon from organic matter that would otherwise decompose without oxygen (anaerobically) and release previously sequestered carbon into the atmosphere. Mixing compost with the soil completes the carbon sequestration process and is commonly known as “soil storage.”¹ The total emissions avoided by the use of compost were calculated by multiplying the amount of University-produced and deployed compost by the appropriate factors in **Section 12.7**.

12.6. Total Emissions Sequestered from Landscaping and Composting

The **163 MT CO₂e** of sequestered carbon from landscaping and composting in both AY 19 and AY 20 is a 45% increase from AY 12 (see **Figure 23**). The increase in sequestered carbon from AY 12-20 is largely attributable to the planting of more trees and groundcover on campus and to the increased use of compost.²

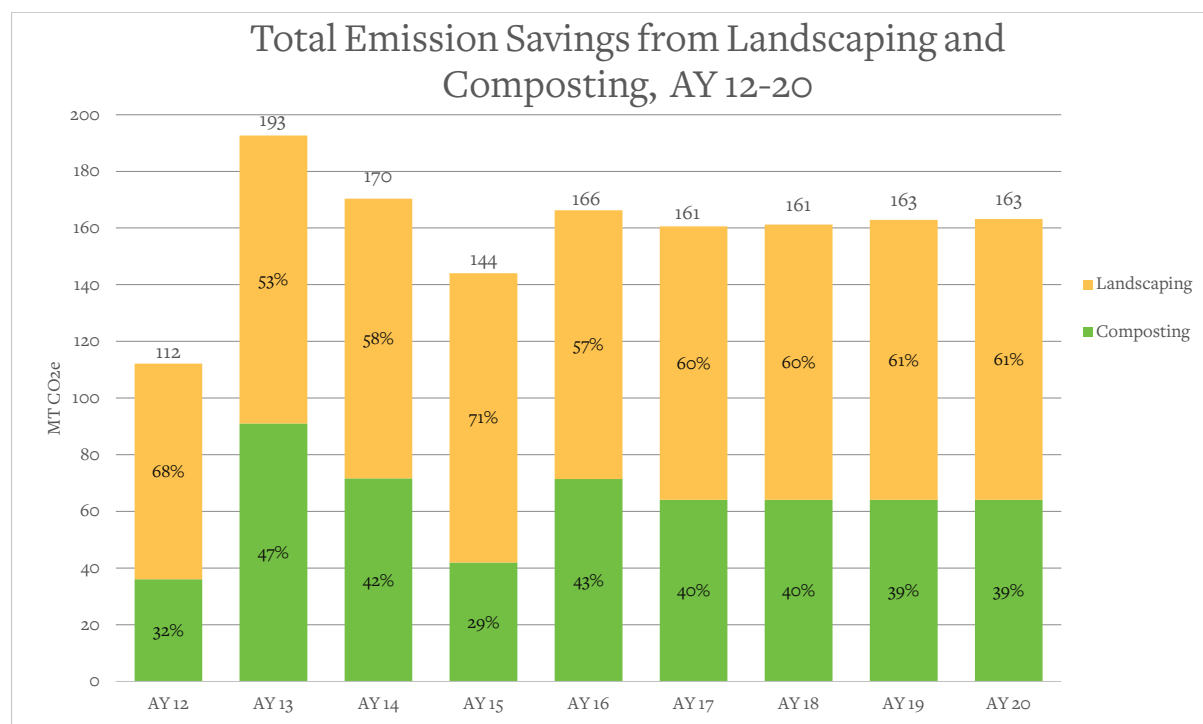


Figure 23. Total emissions offset from landscaping and composting.

¹ This factor only applies to compost produced by the University because the sequestering of emissions during the production of commercial compost is not directly attributable to the University.

² While the University's landscaping sequesters some carbon from the atmosphere, the considerable energy costs associated with the planting, maintenance and irrigation of campus trees and ground cover in a desert environment most likely result in net positive emissions from this sector.

12.7. Sequestration Factors

Landscaping

Source	Annual Emissions Offsets (kg CO ₂ e/Unit)
Date Palm	6.5/tree*
Groundcover	1,172/acre*
Valencia Orange	10.7/tree**

*(USDA, 2013), **(Kongsager et al., 2012)

Composting

Source	Annual Emissions Offsets (kg CO ₂ e/MT compost)***
Soil Storage through Composting	240
Compost Transportation and Production	-40

*** (EPA, 2020)

Chapter 13

AUC's Energy Use Intensity (EUI)

1 NO
POVERTY



2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



4 QUALITY
EDUCATION



5 GENDER
EQUALITY



6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
ECONOMIC GROWTH



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



10 REDUCED
INEQUALITIES



11 SUSTAINABLE CITIES
AND COMMUNITIES



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



14 LIFE
BELOW WATER



15 LIFE
ON LAND



16 PEACE, JUSTICE
AND STRONG
INSTITUTIONS



17 PARTNERSHIPS
FOR THE GOALS



13.1. Summary

As with other university carbon footprints, campus energy consumption is the main determinant of AUC's carbon footprint. To benchmark our individual University findings, we compared AUC's Energy Use Intensity (EUI) to the EUI of six American Universities that operate in similar climates. EUI is the measurement of an institution's annual energy consumption. In the United States, EUI is often expressed in million British Thermal Units (MMBTU) as a function of its size in gross square feet (f²). EUI is particularly useful for comparing the energy performance of functionally similar institutions (Office of Energy Efficiency & Renewable Energy, 2020).

As noted in **Figure 1** and **Section 3.1**, about 41% of the University's carbon emissions in AY 20 are attributable to HVAC and domestic hot water. Moreover, air conditioning is AUC's single largest sector of energy consumption and one of its biggest sources of carbon emissions.

Accordingly, for EUI comparisons we focused on institutions operating in hot, dry climates similar to New Cairo. The six institutions used for comparison to AUC, shown in **Figure 24**, are all located in IECC/ASHR climate zones 2B or 3B. These climate zone classifications are considered "hot-dry" in the U.S. (Office of Energy Efficiency & Renewable Energy, 2020). The energy consumption and gross square footage of each institution compared to AUC in **Figure 24** is taken from its most recent update of Second Nature, a climate action reporting platform for higher education institutions (Second Nature, 2020). The energy consumption and gross square footage of AUC in AY 20 were obtained from AUC's Office of Facilities and Operations.

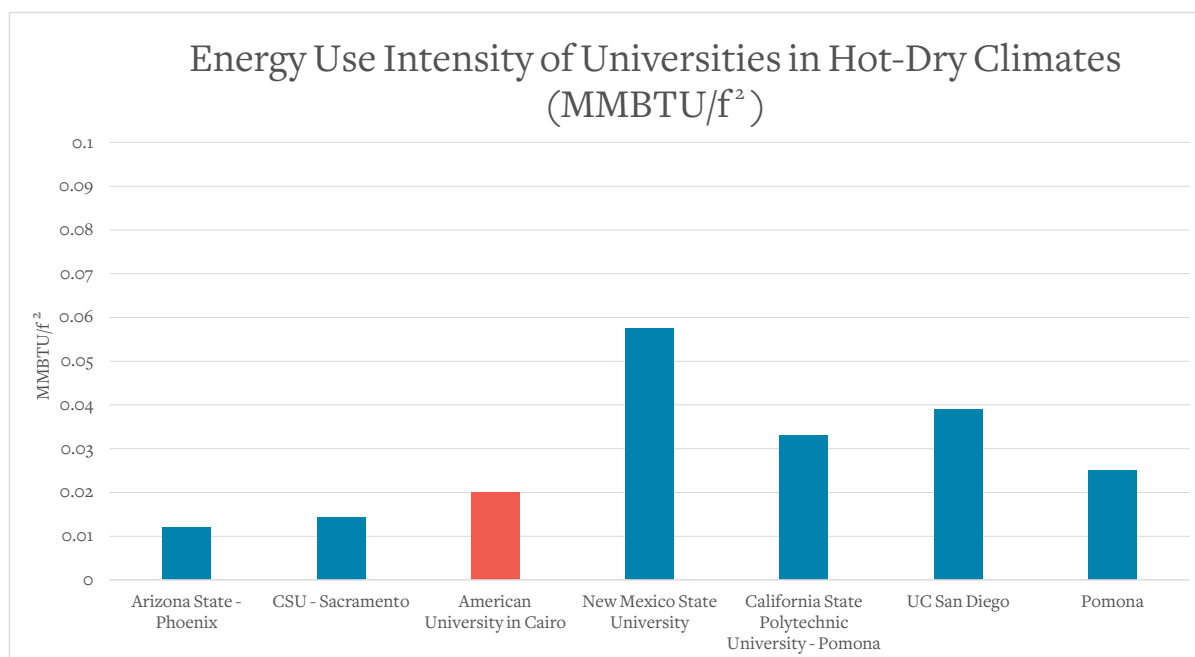


Figure 24. Energy Use Intensity (EUI) of universities in hot-dry climates.

13.2. Carbon Emissions per Total Enrollment

Another useful way to compare AUC to other universities is by carbon emissions per total enrollment [full-time + part-time student population]. Again, the most germane comparison is to universities operating in similar climate zones.

Table 2 compares AUC to the same six institutions located in hot-dry U.S. climate zones, but on the basis of carbon emissions per total enrollment. The energy consumption and student enrollment of each institution compared to AUC in **Table 2** is taken from its most recent report to the American College and University Presidents' Climate Commitment.

Table 2. Rankings of selected institutions of higher education by greenhouse gas emissions per total enrollment. Figures represent net emissions reflecting carbon offsets (Second Nature, 2020).

Institution	Latest Report Year	Total Enrollment	Total Emissions (MTCO ₂ e)	Total Emissions (MTCO ₂ e)/Total Enrollment
Arizona State University	2019	73,398	58,424	0.8
California State U. - Sacramento	2019	27,144	15,422	0.6
The American University in Cairo	2020	6,514	25,527	3.9
New Mexico State University	2017	12,261	58,567	4.8
California State Polytechnic University - Pomona	2019	23,078	34,973	1.5
University of California - San Diego	2018	38,673	182,292	4.7
Pomona College (California)	2018	1,659	9,350	5.6

13.3 Data Sources

The energy consumption and student enrollment of AUC in AY 20 were obtained from AUC's Office of Facilities and Operations and Office of Strategy Management and Institutional Effectiveness (SMIE), respectively.

Chapter 14

Recommendations and Vision Forward



14.1. Concluding Remarks

Tracking emissions since AY 12 has provided the AUC Community with abundant data about its yearly performance. Evaluating research findings from the past nine-year period is critical toward understanding the variables and constants affecting annual carbon emissions. This data enables the AUC Community to not only measure its current performance against the past, but to set realistic targets for future carbon emission reductions. With a system in place for tracking carbon emissions campus-wide, AUC can now focus its efforts on the implementation of new projects, plans or operational changes that would bring about the intended carbon emissions reductions and targets.

The novel coronavirus (COVID-19) has caused observable changes in AUC's emissions. In AY 20, the AUC campus was impacted by a compulsory halt of on-campus presence through the transition to online teaching modality and remote working in March 2020. This change has resulted in decreases in most components of AUC's carbon footprint (except for non-occupancy-related campus operations, such as landscaping). The declines in energy consumption and emissions on campus are inline with the worldwide trends. However, it is important to note that due to increased use of communication technologies and energy at home, the transition to online teaching and remote work has also pushed AUC's carbon footprint beyond its physical campus boundaries.

Looking beyond the effects of the COVID-19 crisis on AY 20 emissions, two key determinants will shape AUC emissions' future. On one level, there are uncertainties around the mode of teaching and operation in the coming year. Depending on the level of hybridity adopted by AUC, the benchmark of emissions might change significantly - where in a fully online modality, we might witness further decreases, and with a total return to campus, we would witness a return to pre-AY 20 levels. On a second level, we see a shift in the global agenda towards mediating the consideration of energy consumption and emissions with health and wellbeing. Thus, the challenge in the coming years will be to continue our efforts to curb AUC's emissions and footprint while also prioritizing our community's health and wellbeing. These health considerations bring the emergence of new concepts such as "Shifting Spaces", which highlights the lasting impact the health crisis may have on constructing the spaces we occupy (AUC Today, 2021). This shift could result in new regulations and policies related to fresh air and filtration at present and in the future and will accordingly affect campus-wide energy consumption (as it relates to HVAC, for example). These scenarios are explored further in **Section 14.3**.

The COVID-19 crisis has allowed us to develop the flexibility to adapt to these uncertainties through collaborative and dynamic approaches to crisis management. Within this context, **Section 14.2** presents a series of recommendations at the intersection of emissions and health considerations. The recommendations are linked to the Sustainable Development Goals (SDGs) they specifically address in order to facilitate a comprehensive understanding of which areas of sustainable development are being addressed by University efforts, and which areas need further consideration or action.

The implementation of different recommendations brings with them varying challenges and levels of difficulty to transform the ideas into reality. As such, more detailed investigations, feasibility studies and prototyping trials will be necessary before implementation. Embedded within an academic and research institution, AUC provides the landscape needed to explore, develop, and implement the ideas that can be generated throughout the broader community.

14.2. Recommendations

The listed recommendations below can be implemented to reduce AUC's carbon footprint. A focus group comprised of University facility operators, professors, and students was utilized to collect initial ideas. Then, the core research team compiled and combined the initial ideas and compared the shortened list with sustainability initiatives at other institutions of higher education. From this comparison, the list of recommendations was aligned with the recommendations of previous Carbon

Footprint Reports as well as with new considerations of the impact of COVID-19 and the subsequent shift of focus from energy savings to health concerns.

The recommendations address the most significant components of AUC's Carbon Footprint, and are presented in chapter order, further distinguished by campus-wide and COVID-related recommendations, when applicable. A new section regarding educational recommendations has also been added. The below visualization also provides a reference for which of the 17 UN Sustainable Development Goals each of the suggested recommendations address, either directly or indirectly.

Heating, Ventilation, and Air Conditioning (HVAC) and Domestic Hot Water

Campus-wide recommendations:

- Explore the use of solar heaters for the absorption chillers and to complement. For example, through pre-heating domestic hot water supply.
- Perform an assessment of the post-occupancy physical changes and their impact on the original mechanical design of the University.
- Administer a cooling shutdown in selected days throughout the year with favorable outdoor and indoor temperatures, in compliance with ASHRAE 90.1 and 62.1 codes.

Room-level recommendations:

- Upgrade and maintain windows to minimize infiltration in individual rooms.
- Explore shades for self-regulation of heating and cooling in individual rooms.
- Implement partial HVAC system upgrades to enhance controllability and comfort level in individual rooms.

COVID-related recommendations:

- Conduct an analysis to identify any potential for HVAC-related cross-contamination in spaces.
- Explore the potential for filter upgrades, especially in collective and large spaces.



Transportation

Campus-wide recommendations:

- Develop an “AUC Transportation App” to create a carpooling network and include an interactive bus schedule and route map.
- Expand bus times and routes available to incentivize bus commuting.
- Consider converting the University’s own transportation fleet and its commuter buses from diesel- and gasoline-burning vehicles to vehicles that run on clean energy.
- Allocate charging stations for electric and hybrid vehicles in parking spaces nearest to the portal entrances, as well as ensure that the electricity utilized at such stations is renewably sourced.

Neighborhood-level recommendations:

- Integrate a bike-share system with the New Cairo area, and expand pedestrian and bike access to surrounding commercial and residential zones.
- Explore new public transportation options, including a metro station for New Cairo with connections to the greater Cairo area.

COVID-related recommendations:

- Explore ways to increase density in buses without compromising the health of the community.



3 GOOD HEALTH AND WELL-BEING



7 AFFORDABLE AND CLEAN ENERGY



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



10 REDUCED INEQUALITIES



Electricity for Lighting and Other Equipment (Non-HVAC)

Campus-wide recommendations:

- Install solar panels in parking lots and existing building rooftops.
- Expand the use of motion sensors to all corridors.
- Install occupancy sensors in individual offices.
- Establish an Eco-Rep Program to monitor electricity usage in student residences and campus buildings.
- Develop an incentive system that rewards buildings or departments that utilize the least amount of electricity.
- Create a policy in coordination with the University for furthered or forced shutdown of unused office equipment and lights.
- Replace all non-energy efficient lights with energy-efficient ones.
- Other recommendations
- Shift more of the University’s electricity sourcing to a more carbon efficient provider.

COVID-related recommendations:

- Monitor and provide mechanisms to ensure that near-zero energy consumption for unused classrooms.
- Optimize classroom utilization classrooms to maximize energy savings.



4 QUALITY EDUCATION



16 PEACE, JUSTICE AND STRONG INSTITUTIONS



17 PARTNERSHIPS FOR THE GOALS



Refrigerants

Campus-wide recommendations:

- Increase the use of non-chlorofluorocarbon (CFC) compliant refrigerants by phasing out from the traditional use of the refrigerant R22 to exclusively use R407c, a more environmentally friendly alternative.



Paper Use

Campus-wide recommendations

- Adopt a University policy for making the default setting on all computers two-sided printing and promote online media instead of print media.
- Establish centralized printers in all offices and remove desktop or personal printers.
- Formulate a yearly paper audit for all departments and create a committee to evaluate University-wide paper consumption.
- Research sources of affordable, high-quality recycled paper to reduce the net carbon footprint of virgin, purchased paper.



Water Supply

Campus-wide recommendations:

- Phase-in low-flow faucets and water filters University-wide
- Adopt a University policy for air conditioning cooling tower maintenance.
- Reduce consumption of domestic water and increase consumption of treated wastewater for air conditioning, cooling towers, and buildings.
- Enhance the treated wastewater plant or upgrade the facilities by adding a new water tank with high capacity and sterilizing equipment.
- Investigate engineering solutions to increase the use of greywater for flushing across campus.
- Increase the use of drought resistant and salt resistant grasses, plants, shrubs, and trees in campus landscaping.

Other Recommendations:

- Research engineering solutions to capture rainwater from more frequent rains in New Cairo.



Solid Waste Disposal

Campus-wide recommendations

- Phase-out single-use plastic (bottles, bags, containers, and balloons) University-wide
- Research the feasibility of creating a composting facility to capture food waste by vendors and by faculty, staff, and students.
- Encourage food vendors to use more sustainable takeaway packaging and to provide more reusable options (cups, bottles, containers) Introduce sorting stations within buildings, and enhance the sorting methods and locations of outdoor bins University-wide.
- Implement a permanent paper recycling system across all University suites.
- Enact University policy for zero-waste event planning and execution.

Other recommendations

- Work with waste collectors and local authorities on minimizing transportation and secondary emissions resulting from waste processing.



Natural Gas for Domestic and Lab Use

Campus-wide recommendation:

- Meter individual labs to monitor and decrease consumption.



Other Educational and Developmental Recommendations

- Establish a Sustainability Ambassador program for students to champion sustainable behaviors on campus.
- Integrate sustainability and carbon-related topics in the orientation activities for students, staff and faculty.
- Create a carbon emission reduction educational module that is mandatory for all the AUC community, which presents:
 - An overview of the current situation and the past interventions
 - A basic introduction to sustainability and sustainable living
 - Recommendations for efforts and pro-environmental behaviors that individuals can adopt to help reduce AUC's emissions.
- Launch awareness campaigns – championed by students to heighten the sensibility of the AUC community on various topics such as:
 - Plastic waste
 - Organic waste and composting
 - Electricity and plug loads
 - HVAC loads
- Utilize energy savings to establish a sustainability fund to support future initiatives for carbon reduction and other optimization projects



14.3. AUC's Emissions Forecast

The emission drop witnessed in AY 20 because of COVID-19 suggests that AUC's emissions forecast is highly contingent on future teaching modalities and campus occupancy levels. The Emissions Forecast in **Figure 25** provides the baseline context for current carbon emissions as well as projections of future emission scenarios for AUC over the next six years by considering both the changes in the modalities of instruction and the varying levels of investment in green and sustainable technologies.

We propose two alternatives for teaching modalities: (1) continuing the hybrid model with 50% campus utilization or (2) returning to full face-to-face instruction. A third alternative (3), expects a return to full face-to-face modality, but with increased health consideration such as adding more filtration. Each of the alternatives are accompanied by three scenarios of carbon emission reduction strategies. The details of the alternatives and their subsequent scenarios are presented in **Box 2**.

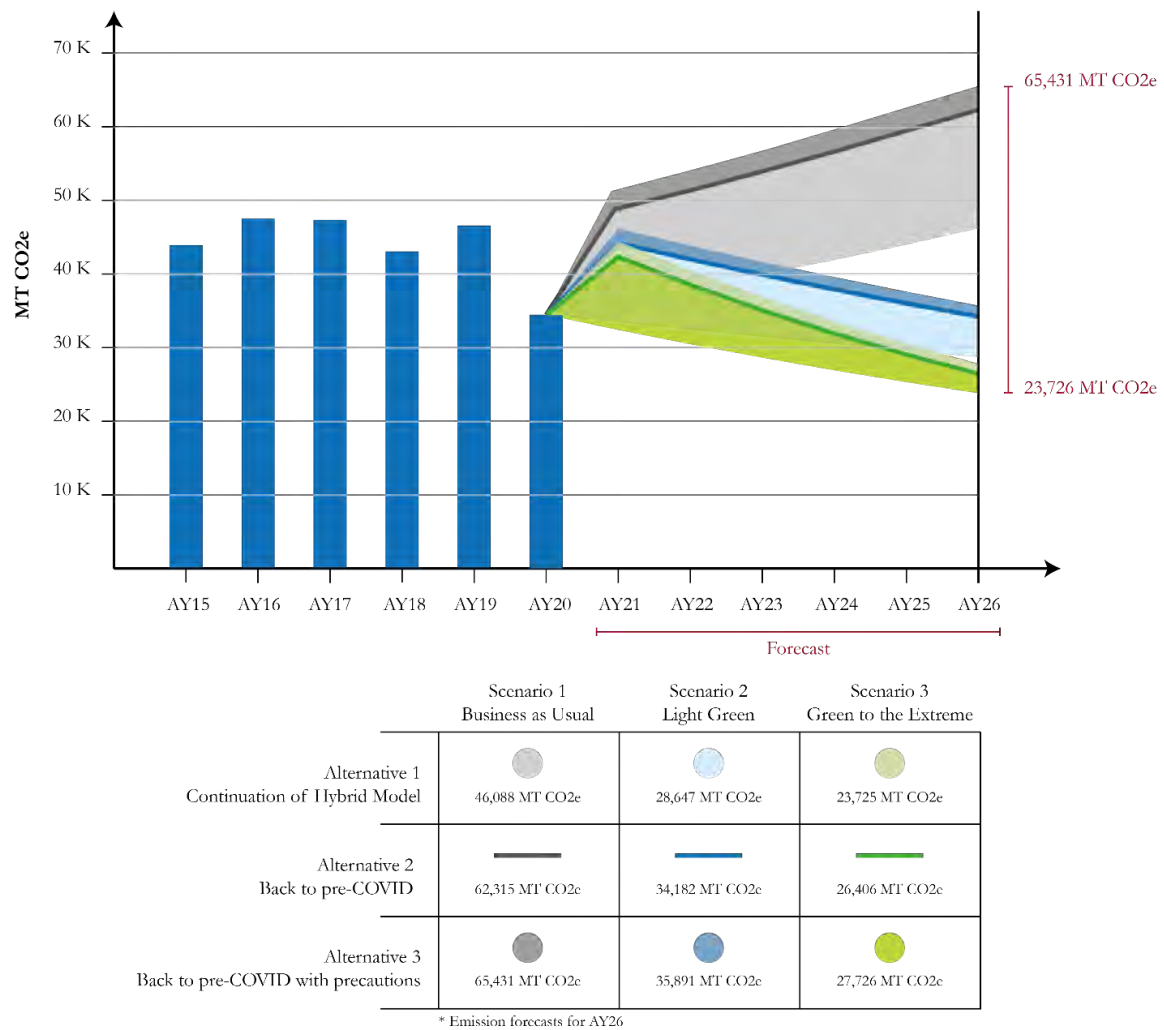


Figure 25. Emissions Forecast

As presented in **Figure 25**, to maintain AY 20 carbon emission levels with an on-campus teaching modality (Alternative 2) adopting the Light Green Scenario is required. The Business-as-Usual Scenario, especially if stricter health and wellbeing considerations are adopted (Alternative 3), could significantly increase emissions to unprecedented levels (with a forecast beyond 65,400 MT CO₂e). The forecast also proposes that even with a hybrid teaching modality (Alternative 1), the Business-as-Usual Scenario would return AUC's emissions to its AY19 emission levels within the next six years (at around 46,000 MT CO₂e). On the other hand, aggressive investments, and interventions to curb emission, as illustrated in the Green to the Extreme Scenario, could help the University bring its carbon footprint below the 30,000 MT CO₂e under all teaching modalities.

	Scenario 1: Business as usual	Scenario 2: Light green	Scenario 3: Green to the extreme
Alternative 1*: Continuation of Hybrid Model (50% capacity) *	Assumes normal operations, continuing at the same rate of emissions increase given the projected rate of campus growth until 2030. The expected net emissions increase approx. 5% per year from AY 20 levels.**	- Investment and implementation of a modular solar plant for power supply. - Improve building level efficiencies. The expected net emissions reductions approx. 3% per year from AY20 levels.***	- Investment and implementation of a modular solar plant for power supply. - Improve building level efficiencies. - Source power from cleaner energy sources such as offsite wind farms, solar or other alternatives. The expected net emissions reductions approx. 6% per year from AY20 levels.
Alternative 2**: Back to pre-COVID (Full campus usage)	Assumes normal operations, continuing at the same rate of emissions increase given the projected rate of campus growth until 2030. The expected net emissions increase approx. 5% per year from AY18 levels.***	- All Alternative 1: Scenario 2 recommendations - Increase carpooling The expected net emissions reductions approx. 5% per year from AY18 levels.***	- All Alternative 1: Scenario 3 recommendations - Increase carpooling - Replace current University bus and car fleet with hybrid or electrically operated vehicles. The expected net emissions reductions approx. 9% per year from AY18 levels.
Alternative 3: Back to pre-COVID with precautions (Full campus usage + increased filtration and health considerations)	Assumes an increase in HVAC related emissions for additional filtration and health considerations Increases overall Alternative 2: Scenario 1 emissions by approx. 5%.	- All Alternative 2: Scenario 2 recommendations - Assumes an increase in HVAC related emissions for additional filtration and health considerations Increases overall Alternative 2: Scenario 2 emissions by approx. 5%.	- All Alternative 2: Scenario 3 recommendations - Assumes an increase in HVAC related emissions for additional filtration and health considerations Increases overall Alternative 2: Scenario 3 emissions by approx. 5%.
* We use AY 20 as the benchmark for Alternative 1, since 50% of year (from March to august) utilized the online modality. ** We use AY 18 as the benchmark for Alternative 2 (pre-COVID benchmark) *** Follows a compounding model - to reflect continued investment year over year till AY26			

Box 2. Emission Scenarios for the next six years.

14.4. Vision Forward

With uncertainties around the teaching modality and health consideration in the upcoming years, adopting some carbon reduction strategies is essential to stabilize AUC's emissions. Scenarios 2 and 3 provided in **Box 2** provide insights into the areas that AUC can target to reduce future carbon emissions further. While operational investments are necessary for stabilizing or reducing emissions, buy-in from the AUC community are necessary for their success and sustainability. Thus, there is an imminent need for the institution to be more active in raising awareness and championing sustainability and carbon-reduction behaviour – as presented in our last set of recommendations in **Section 14.2**.

While emissions remain a financial externality for AUC, new regulations on both the global and local scales could potentially price pollution. In recent years, governments in North America and Europe have started to adopt various carbon pricing models - such as the “Cap & Trade” and “Carbon Tax” models. If such regulations are put in place in the region, the Business-as-Usual Scenario will increase operational expenses related to offsetting or paying the price of pollution. On the other hand, adopting carbon reduction strategies could place AUC in an advantageous position and potentially generate new revenue streams for the University under a Cap & Trade model.

By aligning its vision and planning with consideration towards national and international goals, AUC elevates its efforts in counteracting growing environmental and health concerns. Through the production of the Carbon Footprint Report, AUC provides not just the vision of global sustainability, but the concrete information, resources, and tools necessary to produce impactful results and outcomes.

REFERENCES

- African Vault. (2017, September 18). Top 20 oil producing countries in Africa. <https://www.africanvault.com/oil-producing-countries-in-africa/>
- AUC Office of Strategy Management and Institutional Effectiveness (SMIE). (2019). Factbook 2018-2019, Factbook 2019-2020. Rep. Cairo: American U in Cairo.
- AUC Today. (2021, March 16). Shifting Spaces. auctoday.com. <https://auctoday.com/2021/03/03/shifting-spaces/>
- Carbon Visuals (2012, November 29) Actual Volume of One Metric Ton of Carbon Dioxide Gas. Flickr. Yahoo!. <https://www.flickr.com/photos/carbonquilt/8228691679/>
- Climate Action Tracker. (2020, December). Temperatures: Addressing Global Warming. Temperatures | Climate Action Tracker, www.climateactiontracker.org/global/temperatures/
- Climate Technology Centre & Network (CTCN). (1999). Clean Air Cool Planet (CA-CP) Campus Carbon Calculator. Climate Technology Centre & Network, UN Environment. <https://www.ctc-n.org/resources/clean-air-cool-planet-ca-cp-campus-carbon-calculator>
- Department for Environment and Rural Affairs, Department of Energy & Climate Change (DEFRA/DECC) (2020). Greenhouse Gas Reporting - Conversion Factors 2020. UK Government. <https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020>
- Egypt Green Building Council (Egypt GBC). (2021). Sustainability and COVID-19. Egypt GBC: Egypt Speaks Green Webinar #5. https://www.youtube.com/watch?fbclid=IwAR1aVJtFViuYQj4xgDswHxvpioRHt2KCwNPMcwJ6WjZqQIZs_k4Hd6Z9jCQ&v=d2fpQccR4XI&feature=youtu.be
- Egyptian Environmental Affairs Agency (EEAA). (2012). Annual Report of the Egyptian Electricity Holding Company 2011/2012. Egypt: Ministry of Electricity and Renewable Energy.
- Egyptian Environmental Affairs Agency (EEAA). (2014). Annual Report of the Egyptian Electricity Holding Company 2013/2014. Egypt: Ministry of Electricity and Renewable Energy.
- Egyptian Environmental Affairs Agency (EEAA). (2016). Annual Report of the Egyptian Electricity Holding Company 2015 / 2016. Egypt: Ministry of Electricity and Renewable Energy.
- Egyptian Environmental Affairs Agency (EEAA). (2017). Annual Report of the Egyptian Electricity Holding Company 2016 / 2017. Egypt: Ministry of Electricity and Renewable Energy.
- Egyptian Environmental Affairs Agency (EEAA). (2019). Annual Report of the Egyptian Electricity Holding Company 2018 / 2019. Egypt: Ministry of Electricity and Renewable Energy.
- Egypt Vision 2030. (2018). Sustainable Development Strategy: Egypt Vision 2030. Egyptian Cabinet. <http://sdsegypt2030.com/?lang=en>
- Environmental Justice Atlas (EJA). (2017). Multinational takeover threatens the livelihood of the Zabbaleen, Egypt. Environmental Justice Atlas. <https://ejatlas.org/conflict/zabbaleen>
- Environmental Paper Network. (2018). Paper Calculator. Environmental Paper Network <https://c.environmentalpaper.org/>
- Glossary of Climate Change Acronyms and Terms. (2014). United Nations Framework Convention on Climate Change. Retrieved 10. Jan. 2019 http://unfccc.int/essential_background/glossary/items/3666.php#C
- Food and Agriculture Organization of the United Nations (FAO) (2006). Sources of plant nutrients and soil amendments. Food and Agriculture Organization of the United Nations. <http://www.fao.org/docrep/pdf/009/ao443e/ao443e03.pdf>
- Intergovernmental Panel on Climate Change (IPCC). (2006). IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change. Volume 4, Chapter 11: N₂O Emissions from Managed Soils, and CO₂ Emissions from Lime and Urea Application; Ed. De Klein, Cecile, Novoa, Rafael and Ogle, Stephen. The United Nations.
- IPCC. (2018). Summary for Policymakers of IPCC Special Report on Global Warming of 1.5 C approved by governments. Intergovernmental Panel on Climate Change. Ed. V Masson-Delmotte, P. Zhai, and H. O. Portner. The United Nations.

- Liu, Z., Ciais, P., Deng, Z. et al. (2020). Near-real-time monitoring of global CO₂ emissions reveals the effects of the COVID-19 pandemic. *Nat Commun* 11, 5172. <https://doi.org/10.1038/s41467-020-18922-7>
- Mostafa, Mohamed K., et al. (2021). The Impact of COVID 19 on Air Pollution Levels and Other Environmental Indicators - A Case Study of Egypt. *Journal of Environmental Management*, vol. 277, 2021, p. 111496., <https://pubmed.ncbi.nlm.nih.gov/33069147/>
- Office of Energy Efficiency and Renewable Energy. (2017). Climate Zones: Buildings. Energy.gov <https://energy.gov/eere/buildings/climate-zones>
- Second Nature Inc. (2020). Reporting Platform. Second Nature. Retrieved 11 March, 2020. <http://reporting.seconnature.org/>
- Stahl, R., and A. B. Ramadan. (2008). Environmental Studies on Water Quality of the Ismailia Canal / Egypt. Karlsruhe: Forschungszentrum Karlsruhe GmbH.
- United Nations (2020). UN/DESA Policy Brief #81: Impact of COVID-19 on SDG Progress: a Statistical Perspective. United Nations, United Nations, Department of Economic and Social Affairs. www.un.org/development/desa/dpad/publication/un-des-a-policy-brief-81-impact-of-covid-19-on-sdg-progress-a-statistical-perspective/
- United Nations Development Programme (UNDP). (2015). Sustainable Development Goals. United Nations Development Programme. <http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>
- United Nations, Egypt. (2020). Egypt COVID-19: Response and Recovery Interventions of the United Nations in Egypt. United Nations Egypt. <https://egypt.un.org/sites/default/files/2020-09/COVID%2019%20Egypt%20Final.pdf>
- United Nations Environment Programme (UNEP). (2019). Cut Global Emissions by 7.6 Percent Every Year for next Decade to Meet 1.5°C Paris Target - UN Report. UN Environment, UN Environment Programme. www.unep.org/news-and-stories/press-release/cut-global-emissions-76-percent-every-year-next-decade-meet-15degc
- U.S. Environmental Protection Agency (EPA). (2015a). Documentation for Greenhouse Gas Emission and Energy Factors used in the Waste Reduction Model (WARM). U.S.: U.S. Environmental Protection Agency Office of Resource Conservation and Recovery: WARM Version 13. https://www.epa.gov/sites/production/files/2016-03/documents/warm_v14_management_practices.pdf
- EPA. (2020). Emission Factors for Greenhouse Gas Inventories. U.S. Environmental Protection Agency <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>
- EPA. (2020b). Greenhouse Gas Equivalencies Calculator. U.S. Environmental Protection Agency. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>
- U.S. Department of Agriculture (USDA). (2013). CUFR Tree Carbon Calculator. U.S. Forest Service, Climate Change Resource Center: United States Department of Agriculture. <https://www.fs.usda.gov/ccrc/tools/tree-carbon-calculator-ctcc>
- World Health Organization (WHO). (2020). Coronavirus Disease (COVID-19): Climate Change. World Health Organization, World Health Organization. www.who.int/news-room/q-a-detail/coronavirus-disease-covid-19-climate-change
- Zafar, Salman. (2018). Garbage Woes in Cairo. Echoing Sustainability in MENA. <https://www.ecomena.org/garbage-cairo/>

Appendix 1: New Cairo Campus and Map of Greater Cairo

New Cairo Campus, Aerial Photo



Map of Greater Cairo



Appendix 2: Description of the Central Utility Plant (CUP)

Chilled Water for Air Conditioning

The Central Utility Plant (CUP) produces all of the chilled water used for air conditioning buildings, all of the hot water used for heating, and most of the domestic hot water and electricity on campus. A few areas, such as the Rare Books Library, use stand-alone air conditioning units. Chilled water is produced by five absorption chillers, which are fueled by natural gas. Waste heat produced by the condensers in the absorption chillers is released through the evaporation of water from five cooling towers adjacent to the absorption chillers. The cooling towers are shown in **Image 5**.

Chilled water pumps circulate the chilled water to 150 Air Handling Units (AHUs) throughout the campus. The AHUs cool the air using the chilled water which passes through the AHU cooling coils. The cold air is then circulated to air-conditioned zones by more than 1,200 Variable Air Volume (VAV) units.



Image 5. Cooling towers at the Central Utility Plant (CUP).

Hot Water for Heating and Domestic Hot Water

All of the hot water for heating and much of the domestic hot water used on campus is produced at the Central Utility Plant (CUP). In locations where demand for domestic hot water is relatively low, such as restrooms in campus office buildings, hot water is supplied by electric hot water heaters.

Three conventional boilers and two heat recovery boilers produce hot water for heating and for domestic hot water. The three conventional boilers heat water by burning natural gas. The heat recovery boilers, by contrast, heat water by using hot exhaust fumes from two of the generators. This is a process known as “co-generation” and is explained below and in **Section 3.2.2**. Hot water produced by the gas-fired boilers and the heat recovery boilers is circulated to individual facilities throughout the campus by electric pumps and then converted to hot air for heating or for domestic hot water use.

Electricity – Principal Uses

It is estimated that 55% of all electricity used on campus in AY 20 was used for HVAC. This percentage

was calculated by tests conducted by the Office of Facilities and Operations, which found that shutting down all major HVAC equipment during working hours reduced campus-wide electricity demand by approximately 45%.

Electricity used for HVAC drives pumps that circulate chilled water and hot water throughout the campus for air conditioning, heating, and domestic hot water. Electricity also powers Air Handling Units (AHUs), Variable Air Volume (VAV) units, fans, and other HVAC equipment that make up our HVAC system. The remaining electricity used on campus is primarily for lighting, office equipment and lab equipment.

Electricity – From Two Sources

73% of the electricity used on campus in AY 20 was produced by four gas-fired generators. As noted, two of the four generators feed their exhaust fumes to heat recovery boilers for co-generation, a process explained more fully below and in **Section 3.2.2**. The remaining 27% of the electricity used on campus in AY 20 was obtained from EEA. The precise mix of electric power drawn from the on-site electricity generators and electric power drawn from the EEA depends on the demand for electricity on campus, the electricity available from each source when needed, and the cost per kilowatt-hour from each source. An electric switchgear allows technicians to adjust the precise amount of electric power drawn from each source.

Co-Generation

Co-generation is the design, construction, and operation of a power plant to generate electricity and to recapture waste heat that can be used elsewhere to produce hot water for heating and domestic hot water. The main benefits of co-generation are reduced fuel consumption, reduced energy costs and reduced carbon emissions compared to using conventional, gas-fired boilers to produce hot water.

As discussed in **Section 1.5** and **Section 3.3.2** of this report, the Central Utility Plant (CUP) has two of the four gas-fired electricity generators feeding hot exhaust fumes to heat recovery boilers that produce hot water for heating and domestic hot water.

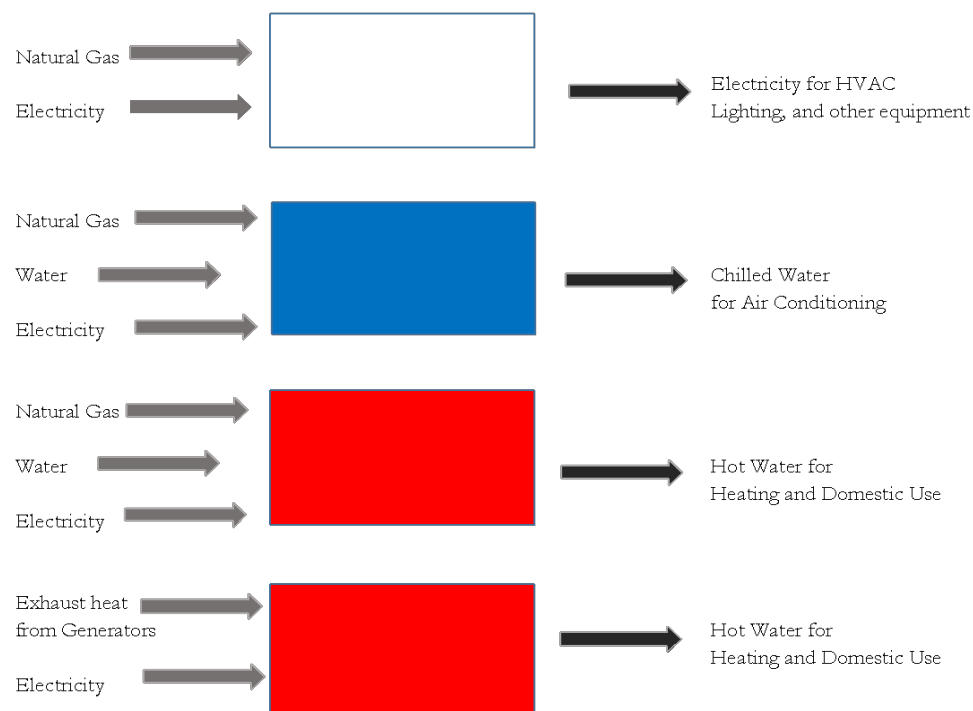


Figure 26. Diagram of inputs and outputs at the Central Utility Plant (CUP).

Appendix 3: Differences in Emissions from AY 12 to AY 20 Using AY 20 Methodologies

	AY 12	%	AY 13	%	AY 14	%	AY 15	%	AY16	%
Energy for HVAC and Domestic Hot Water	20,399.6	47.96%	16,925	43.22%	15,831.2	42.3%	16,782.0	38.3%	18,627.0	39.29%
Electricity for HVAC	9,881.0	23.23%	10,732	27.41%	9,994.2	26.7%	10,143.0	23.1%	10,511.0	22.2%
Energy for Chilling and Heating Water	7,719.0	18.15%	6,193	15.82%	5,857.0	15.6%	6,639.0	15.1%	8,116.0	17.1%
Electricity for Lighting and Equip (Non-HVAC)	9,881.0	23.23%	8,781	22.42%	8,177.0	21.8%	8,291.0	18.9%	8,583.0	18.10%
Transportation	8,197.0	19.27%	9,933	25.37%	10,363.1	27.7%	15,523.1	35.4%	14,953.0	31.54%
Commuting by Car	4,889.0	11.49%	4,818	12.30%	5,597.7	14.9%	11,477.4	26.2%	11,477.0	24.2%
Air Travel	879.0	2.07%	2,387	6.10%	2,281.0	6.1%	1,750.0	4.0%	1,168.0	2.5%
Commuting by Bus	1,825.0	4.29%	2,089	5.33%	1,785.8	4.8%	1,640.2	3.7%	1,499.0	3.2%
University Fleet	586.0	1.38%	592	1.51%	623.7	1.7%	638.0	1.5%	793.0	1.7%
Sponsored Trips	18.0	0.04%	47	0.12%	74.9	0.2%	17.5	0.040%	16.0	0.034%
Paper Use	2,196.0	5.16%	1,905	4.86%	1,730.0	4.6%	1,504.0	3.4%	1,652.0	3.48%
Water Supply	721.0	1.70%	620	1.58%	540.2	1.4%	559.0	1.3%	620.0	1.31%
Consumption by Buildings/Irrigation	587.0	1.38%	493	1.26%	412.0	1.1%	415.0	0.9%	474.0	1.0%
Consumption by HVAC	134.0	0.32%	127	0.32%	128.2	0.3%	144.0	0.3%	145.0	0.3%
Refrigerants	565.0	1.33%	430	1.10%	639.8	1.7%	869.0	2.0%	798.0	1.68%
Solid Waste Disposal	517.0	1.22%	512	1.31%	129.25	0.3%	275.41	0.6%	390.0	0.82%
Natural Gas for Domestic and Lab Use	43.5	0.10%	35	0.09%	31.2	0.08%	23.5	0.05%	1,777.0	3.75%
Fertilizers	15.9	0.04%	17	0.04%	16.24	0.04%	12.00	0.03%	14.0	0.03%
Total	42,536.04	100%	39,157.8	100%	37,458.04	100.0%	43,839.0	100.0%	47,414.00	100.0%
	(-112 from Offsets)		(-193 from Offsets)		(-170 from Offsets)		(-144 from Offsets)		(-166 from Offsets)	

	AY17	%	AY18	%	AY19	%	AY20	%
Energy for HVAC and Domestic Hot Water	18,648.2	39.46%	17,192.0	39.99%	19,221.0	41.34%	14,002.0	40.71%
Electricity for HVAC	9,227.2	19.5%	10,075.0	23.4%	11,229.0	24.1%	8,600.0	25.0%
Energy for Chilling and Heating Water	9,421.0	19.9%	7,117.0	16.6%	7,992.0	17.2%	5,402.0	15.7%
Electricity for Lighting and Equip (Non-HVAC)	8,494.0	17.97%	8,243.0	19.17%	9,188.0	19.76%	7,037.0	20.46%
Transportation	14,123.5	29.88%	11,373.1	26.46%	11,688.0	25.14%	8,562.4	24.90%
Commuting by Car	10,887.8	23.0%	8,803.9	20.5%	8,870.0	19.1%	6,462.0	18.8%
Air Travel	1,198.7	2.5%	1,065.0	2.5%	1,048.0	2.3%	965.0	2.8%
Commuting by Bus	1,313.3	2.8%	968.0	2.3%	1,217.0	2.6%	781.0	2.3%
University Fleet	686.9	1.5%	509.0	1.2%	518.0	1.1%	332.4	1.0%
Sponsored Trips	36.9	0.078%	27.2	0.063%	35.0	0.075%	22.0	0.064%
Paper Use	1,326.7	2.81%	1,180.0	2.74%	1,175.0	2.53%	1,313.0	3.82%
Water Supply	757.0	1.60%	672.0	1.56%	603.0	1.30%	561.0	1.63%
Consumption by Buildings/Irrigation	621.0	1.3%	538.0	1.3%	473.0	1.0%	472.0	1.4%
Consumption by HVAC	136.0	0.3%	134.0	0.3%	130.0	0.3%	88.0	0.3%
Refrigerants	1,028.1	2.18%	536.9	1.25%	752.0	1.62%	279.0	0.81%
Solid Waste Disposal	402.0	0.85%	345.0	0.80%	433.0	0.93%	302.0	0.88%
Natural Gas for Domestic and Lab Use	2,466.0	5.22%	3,434.0	7.99%	3,431.0	7.38%	2,326.0	6.76%
Fertilizers	14.8	0.03%	12.7	0.03%	9.5	0.02%	8.9	0.03%
Total	47,260.28	100.0%	42,988.73	100.0%	46,500.50	100.0%	34,391.30	100.0%
	(-161 from Offsets)		(-161 from Offsets)		(-163 from Offsets)		(-163 from Offsets)	

Figure 27. Total Carbon Footprints AY 12 to AY 20.

** The Emissions Factor (EF) for paper drastically increased in AY 18. Therefore, the report team retroactively applied the new EF to data from AY 12-17.

**The values in red are incorrect. The report team does not have access to the data necessary to recalculate natural gas emissions from AY 12-14. Therefore, the emissions do not reflect the updated methodologies used from AY 15-20.

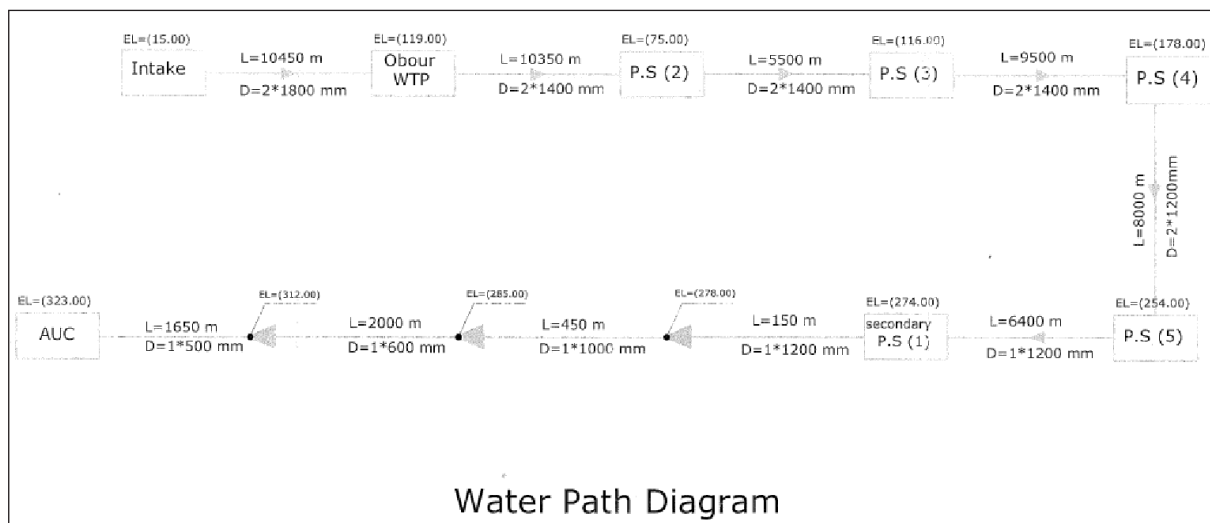
	AY 12	AY 13	AY 14	AY 15	AY16	AY17	AY18	AY 19	AY 20
Energy for HVAC and Domestic Hot Water	20,399.6	16,925.0	15,831.2	16,782.0	18,627.0	18,648.2	17,192.0	19,221.0	14,002.0
Electricity for HVAC	9,881.0	10,732.0	9,994.2	10,143.0	10,511.0	9,227.2	10,075.0	11,229.0	8,600.0
Energy for Chilling and Heating Water	7,719.0	6,193.0	5,857.0	6,639.0	8,116.0	9,421.0	7,117.0	7,992.0	5,402.0
Electricity for Lighting and Equip (Non-HVAC)	9,881.0	8,781.0	8,177.0	8,291.0	8,583.0	8,494.0	8,243.0	9,188.0	7,037.0
Transportation	8,197.0	9,933.0	10,363.1	15,523.1	14,953.0	14,123.5	11,373.1	11,688.0	8,562.4
Commuting by Car	4,889.0	4,818.0	5,597.7	11,477.4	11,477.0	10,887.8	8,803.9	8,870.0	6,462.0
Air Travel	879.0	2,387.0	2,281.0	1,750.0	1,168.0	1,198.7	1,065.0	1,048.0	965.0
Commuting by Bus	1,825.0	2,089.0	1,785.8	1,640.2	1,499.0	1,313.3	968.0	1,217.0	781.0
University Fleet	586.0	592.0	623.7	638.0	793.0	686.9	509.0	518.0	332.4
Sponsored Trips	18.0	47.0	74.9	17.5	16.0	36.9	27.2	35.0	22.0
Paper Use*	2,196.0	1,905.0	1,730.0	1,504.0	1,652.0	1,326.7	1,180.0	1,175.0	1,313.0
Water Supply	721.0	620.0	540.2	559.0	620.0	757.0	672.0	603.0	561.0
Consumption by Buildings/Irrigation	587.0	493.0	412.0	415.0	474.0	621.0	538.0	473.0	427.0
Consumption by HVAC	134.0	127.0	128.2	144.0	145.0	136.0	134.0	130.0	88.0
Refrigerants	565.0	430.0	639.8	869.0	798.0	1,028.1	536.9	752.0	279.0
Solid Waste Disposal	517.0	512.0	129.3	275.4	390.0	402.0	345.0	433.0	302.0
Natural Gas for Domestic and Lab Use	43.5	34.8	31.2	23.5	1,777.0	2,466.0	3,434.0	3,431.0	2,326.0
Fertilizers	15.9	17.0	16.2	12.0	14.0	14.8	12.7	9.5	8.9

Figure 28. Movement of Emissions from AY 12 to AY 20. The green arrow icon represents *increasing emissions*, the yellow upward arrow icon represents *steadily increasing emissions*, the yellow downward arrow icon represents *steadily decreasing emissions*, and the red arrow icon represents *decreasing emissions*. For example, emissions from HVAC and Domestic Hot Water peaked in AY 12. From AY 13-15, HVAC and Domestic Hot Water emissions decreased from AY 12. From AY 16-17, emissions began to steadily increase, but did not move over the peak emissions in AY 12. In AY 18, emissions steadily decreased from AY 16-17. In AY 19, emissions increased and in AY 20, emissions decreased. The emissions for this category were represented by a respective icon.

	AY 12	AY 13	AY 14	AY 15	AY 16	AY 17	AY 18	AY 19	AY 20
Energy for HVAC and Domestic Hot Water	20,399.6	16,925.0	15,831.2	16,782.0	18,627.0	18,648.2	17,192.0	19,221.0	14,002.0
Electricity for HVAC	9,881.0	10,732.0	9,994.2	10,143.0	10,511.0	9,227.2	10,075.0	11,229.0	8,600.0
Energy for Chilling and Heating Water	7,719.0	6,193.0	5,857.0	6,639.0	8,116.0	9,421.0	7,117.0	7,992.0	5,402.0
Electricity for Lighting and Equip (Non-HVAC)	9,881.0	8,781.0	8,177.0	8,291.0	8,583.0	8,494.0	8,243.0	9,188.0	7,037.0
Transportation	8,197.0	9,933.0	10,363.1	15,523.1	14,953.0	14,123.5	11,373.1	11,688.0	8,562.4
Commuting by Car	4,889.0	4,818.0	5,597.7	11,477.4	11,477.0	10,887.8	8,803.9	8,870.0	6,462.0
Air Travel	879.0	2,387.0	2,281.0	1,750.0	1,168.0	1,198.7	1,065.0	1,048.0	965.0
Commuting by Bus	1,825.0	2,089.0	1,785.8	1,640.2	1,499.0	1,313.3	968.0	1,217.0	781.0
University Fleet	586.0	592.0	623.7	638.0	793.0	686.9	509.0	518.0	332.4
Sponsored Trips	18.0	47.0	74.9	17.5	16.0	36.9	27.2	35.0	22.0
Paper Use	2,196.0	1,905.0	1,730.0	1,504.0	1,652.0	1,326.7	1,180.0	1,175.0	1,313.0
Water Supply	721.0	620.0	540.2	559.0	620.0	757.0	672.0	603.0	561.0
Consumption by Buildings/Irrigation	587.0	493.0	412.0	415.0	474.0	621.0	538.0	473.0	427.0
Consumption by HVAC	134.0	127.0	128.2	144.0	145.0	136.0	134.0	130.0	88.0
Refrigerants	565.0	430.0	639.8	869.0	798.0	1,028.1	536.9	752.0	279.0
Solid Waste Disposal	517.0	512.0	129.3	275.4	390.0	402.0	345.0	433.0	302.0
Natural Gas for Domestic and Lab Use	43.5	34.8	31.2	23.5	1,777.0	2,466.0	3,434.0	3,431.0	2,326.0
Fertilizers	15.9	17.0	16.2	12.0	14.0	14.8	12.7	9.5	8.9

Figure 29. Movement of Emissions from AY 12 to AY 20. The emissions of each respective category are organized by a color scheme, with dark red being the highest emissions value and white being the lowest emissions value. The values in between the dark red and white are coded with the colors: light red, lighter red, pink, light pink, and lighter pink, respectively. For example, emissions from HVAC and Domestic Hot Water were the highest in AY 12, and therefore were assigned the color dark red. Emissions from HVAC and Domestic Hot Water were lowest in AY 20, and therefore were assigned the color white. In descending order, the other years were given colors dependent on their placement: AY 12 (darkest red), AY 19 (dark red), AY 17 (light red), AY 16 (lighter red), AY 18 (pink), AY 13 (light pink), AY 15 (lighter pink), AY 14 (lightest pink), and AY 20 (white).

Appendix 4: Domestic Water Supply Delivery Path and Energy Calculation Example



Link from P.S(4) to P.S(5), D1200 mm

Power Calculations:

Pressure head (H) = Static Head + Friction Losses * 1.15 + Residual pressure

$$\begin{aligned} \text{Static Head} &= (254 - 178) \\ &= 76 \text{ m} \end{aligned}$$

Assume $V = 1.15 \text{ m/sec}$

$$\begin{aligned} \text{Friction Losses} \quad H_f &= \frac{6.78 * L * (V/C)^{1.85}}{(D^{1.165})} \\ &= 8.089 \text{ m} \end{aligned}$$

$$\begin{aligned} H &= 76 + (8.089 * 1.15) + 7 \\ &= 92.30 \text{ m} \end{aligned}$$

Power Consumed for each 1L/sec

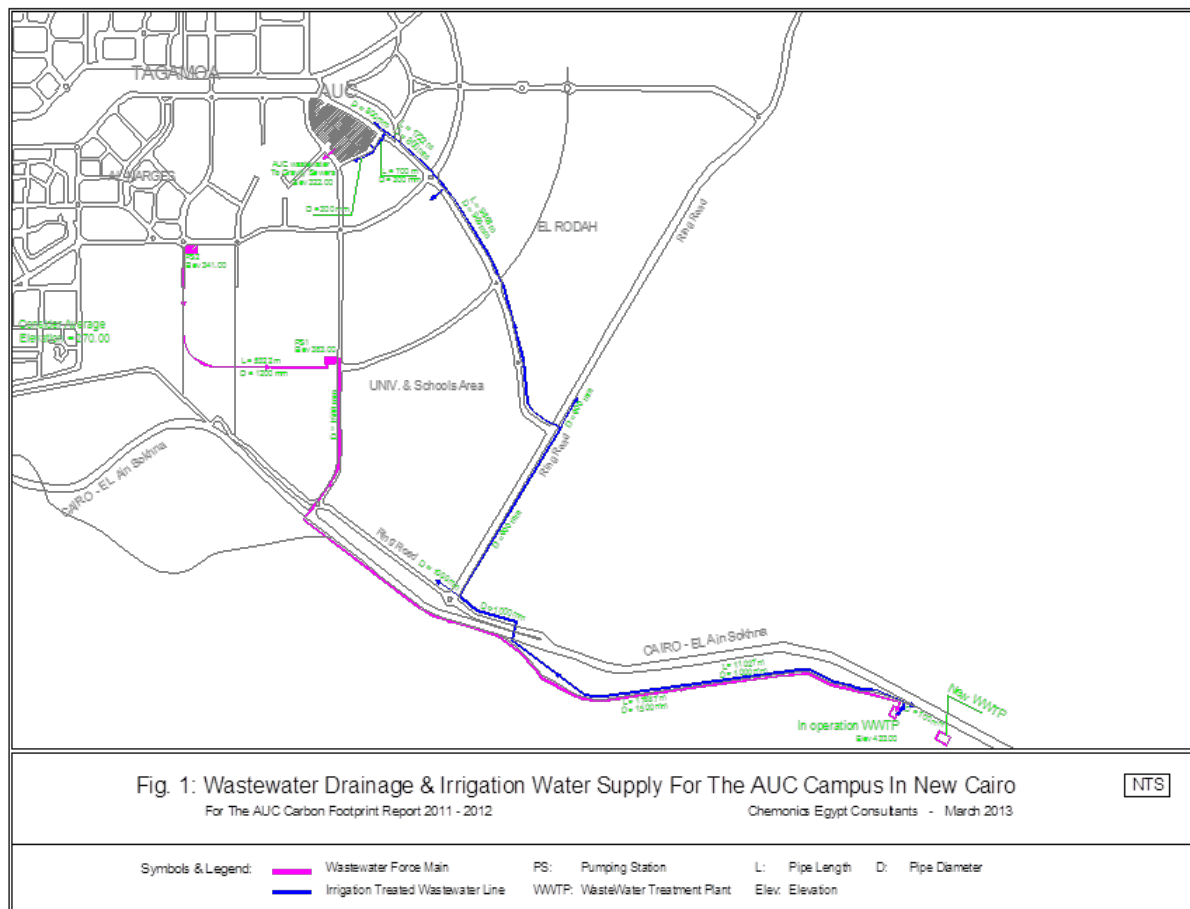
$$P = \frac{H \text{ (m)}}{75 * \eta * 1.34 * 0.85}$$

$$P = 1.662 \quad (\text{kw/1L/sec})$$

Energy Consumption (kw.hr) to let through 1m3

$$\begin{aligned} &= P * (1000/3600) \\ &= 1.662 * (1000/3600) \\ &= 0.461743 \quad \text{kw.hr /m3} \end{aligned}$$

Appendix 5: Treated Wastewater Supply Delivery Path and Energy Calculation Example



Energy Calculations:

The following expression is a simple units' conversion to calculate the pumping energy in kilowatt hours (kWh) after incorporating the efficiency and power factors:

$$\text{Energy in kWh /m}^3 = (\text{kg/m}^3) * 1(\text{m}^3) * \text{Pressure Head (m)} * 9.81 / (1000 * 3600 * \eta * 0.9)$$

- Pumping energy consumed in wastewater collection and transmission:
 - Case 1 (WW originated from the AUC campus) = $1000 * 1 * 161.8 * 9.81 / (1000 * 3600 * 0.55 * 0.9) = 0.891$ kilowatt hours (kWh)
 - Case2 (WW from other average source point) = $1000 * 1 * 213.8 * 9.81 / (1000 * 3600 * 0.55 * 0.9) = 1.177$ kWh
- Pumping energy for treated wastewater supply from the wastewater treatment plant up till the Campus site:
 - Energy consumed in supplying treated wastewater to the AUC Campus location is considered zero.
- Energy consumed in wastewater treatment process:
 - Energy consumed in activated sludge treatment process is estimated according to the given figures deduced out of design and operation records and the long experience in the field of wastewater treatment:
 - Energy consumed by air blowers for each $1\text{m}^3 = 0.4$ kWh
 - Energy consumed by other treatment facilities and sludge pumping and site lighting for each $1\text{m}^3 = 0.2$ kWh

Overall energy factor for collecting and furnishing treated wastewater to the AUC Campus is:

- Case 1 (Wastewater originated from the AUC campus) = $0.891 + 0.6 = 1.49$ kWh/ m^3
- Case 2 (Wastewater from other average source point) = $1.177 + 0.6 = 1.78$ kWh/ m^3

(Overall energy factor previously calculated for fresh water supply = 2.55 kWh/ m^3)

Equivalent Overall Energy Factor:

The equivalent overall energy factor is driven for the purpose of comparing and sensing the energy present and future savings / losses when introducing treated wastewater to water utilities within the AUC New Cairo Campus. The energy factor here is calculated for mixed use of different types of supplied water:

- Equivalent energy factor before introducing treated wastewater to service = **2.55 kWh/ m^3**
- Equivalent energy factor for AY 20 (after covering 40% of irrigation needs by treated wastewater) = $2.55 * 59\% + 1.49 * 41\% = 2.12$ kWh/ m^3 -



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